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HEREDITY VS. ENVIRONMENT: THE EFFECTS OF GENETIC VARIATION WITH AGE

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Summary. Major problems in the field are presented through a brief review of Burt's work and a critical account of the Hawaiian and British schools of biometrical genetics. The need for a covariance term is stressed and an estimate, based on several studies, is given. The merits and demerits of Jencks' study are discussed. There follows an account of the principle of genetic variation with age, a new concept to the heredity-environment field. The new solution, based largely on Jencks' approach and incorporating the genetic variation principle, is then outlined. Its results may be regarded as a compromise between Jencks and Burt in that it agrees with Jencks on the matter of covariance (about 18-19 per cent) but is closer to Burt as far as the relative importance of hereditary and environmental differences is concerned (about 75 : 25). The consistency of the solution with other studies in the field is demonstrated.

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INTRODUCTION

It is indicative of the eminence and authority of the late Sir Cyril Burt that recent criticism of his statistical data should have thrown the educational-psychological world into confusion. Serious doubt is now being cast on his theory of the nature of intelligence, in particular his claim that a high percentage of the variance of measured intelligence (IQ) can be attributed to hereditary differences. There is talk of the need to make a fresh start on the heredity-environment problem; also there is more than a tendency to adopt the view that Burt's figure for the heritability of IQ must be scaled down considerably.

The situation has its dangers. It would be very easy to over-react and fall into mistakes much more serious than any which Burt may have committed. In the first place, the theory at issue is not peculiarly Burt's. It belongs to genetics itself and is implicit in the genetic psychology of that other authority, Jean Piaget. Its truth or validity does not rest therefore entirely with Burt; on the contrary, it has a much broader basis. Consequently, no matter how justifiable the criticism against Burt might be, it does not follow that the theory he supported must now be rejected nor even that its emphasis on the genetic be reduced.

Secondly, when one considers the theory as formulated in terms of heredity-environment variance components, it must be emphasised that the statistical analysis involved can be carried out without recourse to any of Burt's data. Furthermore, as the present study will show, the results of the analysis are not very much different from Burt's as far as the relative importance of hereditary and environmental differences is concerned.

It might be useful if the writer begins with some of his own observations on Burt's work in the heredity-environment field. These observations are based entirely on Burt's publications and not on any personal communications. It might also be claimed that they reveal one or two aspects of Burt's thinking which seem to have escaped his critics.

MAJOR FEATURES OF BURT'S WORK

It is obvious from his article on 'The Multifactorial Theory of Inheritance and its Application to Intelligence' (Burt and Howard, 1956), that Burt was greatly impressed by Fisher's famous paper of 1918. Burt's article consists mainly of an account of Fisher's analysis, but it is clear that his major problem and difficulty arose with the writing of the final section, where he attempts to adapt Fisher's theory so that it can be applied not only to a comparatively simple variable such as height but also to the more complex variable of measured intelligence.

Concerned as he was with a purely genetic theory, Fisher introduces environment into his analysis as a small random factor. While this might be acceptable as far as a biometric variable such as height is concerned, Burt was fully aware that the same did not apply in the case of IQ, where environmental differences are both systematic and random. Thus, there are the environmental factors that are the same for each member of a family, but which differ from family to family; also there are the differences within families. The first might be termed the systematic, the second the random. Furthermore, the environmental differences between families are correlated with the hereditary differences between families. This gives rise to a covariance term in the expression for the total IQ variance. In Burt's 1956 analysis, the covariance is treated as part of the systematic environmental variance. However, this analysis has very serious defects. Harris (1965) was undoubtedly kind when he described it as " a bit primitive ". The main mistake was to treat the intraclass correlation for separated identical twins as a measure of the hereditary component of the IQ variance and to derive the covariance from the residual. In this way, he inflated the hereditary component at the expense of the environmental.

Burt might well have been aware of the inadequacy of his attempt to adapt Fisher. Whether this is so or not, his 1956 paper includes an alternative solution to the problem. Since Fisher was dealing with the simple situation of a purely random environmental factor, Burt tried to put himself in the same position by attempting to adjust his IQs so that they were rid of the systematic factor. Obviously, if the between family environmental effects could be removed, the IQs would then be affected only by the ' random ' within family effects. Moreover, their removal would mean also the elimination of the covariance term. The result was the infamous ' adjusted ' or ' final ' assessments, which were criticised long before the recent attack on Burt.

One must, however, be fair to Burt. Right from the start, he stated quite clearly what he was doing, and he gave what he thought was a reasonable justification for his procedure (Burt and Howard, 1956, pp. 121-122). At the same time, it has to be admitted that there are very few, if any, who would support Burt in what he did. Adjusting IQs appears too much like tampering with data, and it could easily lead to all sorts of malpractices, wittingly or unwittingly. In fact, it would be difficult to argue against anyone who wishes to describe Burt's procedure as unscientific (e.g. Kamin, 1974).

In his last years, Burt makes no reference to his 1956 adaptation of Fisher. Instead, it would appear that he abandoned his earlier attempt and adopted the type of analysis to be found in later writers, in particular Jinks and Fulker (1970). The latter might be described as representing a more refined extension of the biometric-genetic approach initiated by Fisher. Their method, at least as applied to Burt's data, consists essentially of expressing kinship correlations in terms of variance components and then solving for the latter. It is this method which Burt used in his last years, particularly in his very last publication *The Gifted Child* (Burt, 1975).

A special feature of the Jinks and Fulker study is that there is no covariance term. On the basis of F-tests applied to the variances of biological families raised together and apart, they claim that there is no evidence for any significant measure of covariance, and therefore it would be superfluous to include such a term in the analysis. Similarly in his ' Gifted Child ', Burt makes no reference to covariance in the case of IQ, although he does recognise some degree of covariance in respect of educational attainments.

Burt's final analysis is therefore very similar to that of Jinks and Fulker: no covariance term, and the environmental variance no more than 20 per cent of the total variance. In fact, it would be reasonable to say that Jinks and Fulker accepted Burt's data, including the adjusted assessments, and that Burt, in turn accepted their analysis.

In conclusion to this section, it is interesting to note that Jensen (1969), who was greatly influenced by Burt's 1956 paper, shared Burt's difficulty with the covariance term. Although he discusses covariance fully at the beginning of his 1969 article, he seems to ignore it completely when later he speaks of the total IQ variance consisting of 75 per cent hereditary differences and 25 per cent environmental. If he were following Burt, the covariance should be included in the 25 per cent allotted to environment. On the other hand, it would appear from his discussion of the between and within family components of the environmental variance that he required the full 25 per cent for these two items. This would rather suggest that the covariance should constitute part of the 75 per cent for heredity. Obviously his account is far from clear as was pointed out by Light and Smith (1969).

THE BASIC MODEL USED IN HEREDITY-ENVIRONMENT ANALYSIS

Before proceeding further, it is necessary to present a formal statement of the basic model underlying heredity-environment analysis and of the variance components into which the total IQ variance can be analysed.

It is generally agreed that interaction between heredity and environment (in the statistical sense) contributes a negligible amount to the total IQ variance. A simple additive model therefore suffices.

$$IQ = G + E \tag{1}$$

where G is the genotypic value, E the environmental value and all three variables are standardised with mean zero and standard deviation one. Later an important modification will be made in the basic model but, for the moment, equation (1) is sufficient.

The corresponding variance equation is

$$\text{var (IQ)} = \text{var (G)} + \text{var (E)} + 2 \text{ cov (G, E)} \tag{2}$$

where 2 cov (G, E) represents the covariance between heredity and environment.

Both var (G) and var (E) can be analysed into between and within family components. Also, as in biometrical genetics, var (G) can be analysed into three components: additive effects, dominance and assortative mating. Reference will be made to these in the sections which follow.

TWO SCHOOLS OF BIOMETRICAL GENETICS

As Fulker (1974) points out, the aim of biometrical genetics "... is to go beyond simple statements about the relative importance of genetic and environmental influences and to provide information about the genetic architecture ..."

Reference has already been made to the British school, represented in the first place by Fisher (1918) and Mather (1949), later by Jinks, Fulker and Eaves (Jinks and Fulker, 1970; Jinks and Eaves, 1974; and Fulker, 1974).

It might be argued that, in America, one finds a somewhat different approach to biometrical genetics, inspired largely by the work of Sewall Wright (1931). Representative of this approach is the work of the Hawaiian school (Rao *et al.*, 1974, 1976). The writer does not intend to discuss the work of these two schools in detail, but since his own analysis derives from Jencks (1972) and since the latter's approach differs in certain important respects from that of both schools, it is necessary to say something about them.

According to Rao and his colleagues, the essential difference between the two schools lies in their treatment of Mendel's concept of dominance—genes do not necessarily combine in a simple additive manner at any one locus but can interact, thus adding to the genetic variance. The Hawaiian group would claim that the British school radically simplifies environmental effects in order to provide an estimate of dominance deviations; they, on the other hand, regard the environmental effects common to the members of a family as more important than dominance and, in order to deal ' realistically ' with them, are prepared to sacrifice an estimate of dominance.

Probably the differences between the two schools are disappearing. Thus, Rao *et al.* (1974, p. 356) speak of introducing dominance into their path analysis and reporting in a later paper. (As far as the writer knows, this has not yet appeared.) Also the British school has experimented with family environmental components for the two cases (*a*) where shared by children and parents and (*b*) where applicable only to children (Fulker, 1974, p. 104.)

A common feature of both schools is their use of high-powered statistical techniques, Maximum Likelihood and Weighted Least Squares. These provide not only estimates of the relevant parameters and their standard errors, but also tests of goodness of fit of the models employed. The method of maximum likelihood, used primarily by the Hawaiian group, also makes provision for the testing of various hypotheses in respect of the model parameters.

The Hawaiian School

Like Wright (1931) and Jencks (1972), the school uses a path model in order to obtain measures of the relationships between genetic and environmental components, both parental and filial. The Hawaiian model (Rao *et al.*, 1976) differs from Jencks (1972) in that it also includes direct paths between the childhood family environments of the parents and the family environment of their offspring.

With the omission of dominance from the model, the coefficient (g) of the path from the genotype of either parent to that of the child is taken to be ·5. (It might be noted that in the case of dominance, the value of g is less than ·5, ($1-2g$) being the proportion of the genetic variance to be attributed to dominance, and $2g$ being the proportion accounted for by the additive effects and assortative mating.)

Path analysis and the method of maximum likelihood were applied by Rao to Jencks' IQ data (1972). The estimates of the hereditary and environmental components of the IQ variance, which they obtained, are as shown in Table 1.

TABLE 1

VARIANCE COMPONENTS FOR IQ ($m=s=0$)* AS FRACTIONS OF THE TOTAL PHENOTYPIC VARIANCE
(Reproduction of Table 6 in Rao *et al.*, 1976)

Source	Children	Parents
Genotype	·670±·067	·211±·104
Common environment	·094±·045	·506±·245
Genotype-environment covariance	·101±·028	·132±·039
Residual	·135±·016	·151±·131

* m = correlation between parental genotypes.
s = correlation between (childhood) family environment of an adult and the spouse's genotype.

The most striking feature of Rao's 1976 analysis is the large differences between the estimates of the hereditary and environmental components for childhood and adulthood. This, of course, is completely at variance with one of the primary assumptions of both the British school and Jencks, namely that the relative importance of the hereditary and environmental differences is more or less the same for all ages, say from 5 years of age onwards.

A similar result was obtained earlier by Wright in his 1931 article. The latter offered the simple explanation that children and adults are measured at different ages. The Hawaiian group go further than this. They state (Rao *et al.*, 1976, p. 235) that adult heritability is significantly less " presumably because the levelling effect of the school system is replaced by varying stimulation in different occupations ". Since the common environment is the environment shared by siblings, one would have thought that the effect of different occupations would have been to reduce the effect for common environment! (The correlation between the occupational statuses of brothers is quite small, between ·32 and ·38.)

Another major feature of the analysis is that the correlation m between parental genotypes is approximately zero (as also the correlation s between the genotype of one parent and the common environment of the other). This means that the correlation between parental IQs is attributed almost entirely to the correlation between parental childhood environments, i.e. there is little assortative mating in a genetic sense. This result runs completely counter to the point of view held by the British school (Jinks and Eaves, 1974).

Furthermore, for $m = 0 = s$, the correlation between the childhood family environment of spouses is ·985! (One must remember that the correlation between the occupational statuses of the fathers of spouses is only about ·30—Jencks, 1972, p. 317.) Also, from the path model and the estimates obtained, it follows that the correlation between the family environment of the child and that of either of his parents is about ·91. (Again one must remember that the correlation between the occupational statuses of father and son is only about ·44—Jencks, 1972, p. 337.)

Equally strange results are obtained on further analysis. Thus, from Table 1, it follows that the IQs for child and parent (or adult) are given by

$$IQ_c = \cdot 819\ G_c + \cdot 307\ E_{s-c} + \cdot 367\ E_{r-c} \qquad (3)$$

and

$$IQ_p = \cdot 459\ G_p + \cdot 711\ E_{s-p} + \cdot 389\ E_{r-p} \qquad (4)$$

where G_c and G_p are the genotypic values for child and parent (or adult), E_{s-c} and E_{s-p} are the measures of the common (systematic) family environments for child and parent, and E_{r-c} and E_{r-p} are the residual (within family) environmental components (all variables, including IQ, being standardised with mean 0 and standard deviation 1). The correlations $r_{G_c E_{s-c}}$ and $r_{G_p E_{s-p}}$ are each equal to ·201.

From equations (3) and (4), it follows:—

(*a*) Whereas the correlation between siblings (as children) is ·670 (·5) + ·094 + ·101 = ·53, the correlation between siblings (as adults) is ·211 (·5) + ·506 + ·132 = ·74. An increase of ·21 in the correlation, as one goes from childhood to adulthood is rather difficult to accept. (It should also be noted that the Hawaiian school, like the British, treats the correlation for fraternal twins as not differing significantly from that of siblings. This result therefore would apply to fraternal twins as well as siblings.)

(*b*) Similarly, the correlation between child and parent living together is ·46 but for child (as adult) and parent, the correlation is ·63 (again an increase which is difficult to accept).

(*c*) When one considers the correlation between foster child and natural mother, the reverse result is obtained. For the child (as child), the correlation is ·26 but for the child (as adult), the correlation is ·15. This is the very opposite of the empirical result obtained in the Skodak and Skeels (1949) foster child study, where the correlation between foster child and natural mother increases with age of the child.

All in all, it would appear that there is something seriously wrong with the Hawaiian approach, despite the power of its statistical methods. Probably the main source of trouble is the assumption of zero dominance—a criticism that cannot be made of the British school.

In particular, it might be said that the finding of decreasing heritability with age is of doubtful validity and is largely an artefact due to the assumption of zero dominance. Possibly there is a slight decrease with age. On the other hand, it is probably reasonable to assume that heritability is approximately constant, say from 5 years of age onwards. This is the assumption adopted by the British school, by Jencks, and also by the writer in his own analysis.

The British School

The general character of the results, which the school obtained in their analysis of Burt's IQ data, has already been presented in the section on Burt. For the details, in particular their account of what has been termed the ' genetic architecture ', one should consult the articles quoted at the beginning of this section.

If dominance is a central concept in a discussion of the work of the Hawaiian school, it might be argued that covariance becomes an important issue when one considers the work of the British school in respect of IQ. Whereas, in the case of the Hawaiian group (and Jencks), the path model makes covariance possible and a substantial amount of covariance is obtained in the analysis of the IQ data, the British school has always been resistant to the idea of any significant degree of covariance for IQ. Two main arguments are used.

Firstly, if there is any appreciable degree of covariance, then the total IQ variance for separated twins or siblings must be less than for children living with their own parents (assuming that selective placement is relatively unimportant). The British school point out that examination of variances reported by Burt reveal no such difference. However, since the variances were derived from ' adjusted data ' and since the adjustment was designed to remove systematic differences in environment, it is perhaps not surprising that no difference was found.

Secondly, the application of a weighted least squares analysis to Jencks' IQ data (cf. Jinks and Eaves, 1974) gives no evidence for a significant measure of covariance. In this case, of course, the matter of adjustment of data does not arise and the result obtained therefore carries more weight. However, a general feature of the rationale of the techniques of Least Squares and Maximum Likelihood is relevant here. As used by the British and Hawaiian schools, both these methods are applied to empirical data without first attempting any correction for systematic factors (e.g. selective placement) that might have affected the data. Doubtless, this is a necessary condition for the application of the two techniques; also, the argument can be used that, if these factors are present in any considerable measure, their presence will be revealed through a failure of the model to fit the data. Nevertheless, there still exists the distinct possibility that the crude data are such that even the sophisticated techniques employed are not sensitive enough to reveal systematic factors—in particular, covariance.

One must also remember that the crude data are invariably correlation data. The writer rather suspects that in using Maximum Likelihood and Least Squares, one has difficulty in detecting covariance for such data. A simple experiment, in which the techniques are applied to simulated data (consisting of correlations involving heredity-environment covariance) would clear up this point.

Oddly enough, the British school is prepared to recognise a considerable degree of covariance in the case of measures of educational attainment. Thus, Fulker (1974), in an analysis of Burt's correlations for attainment measures, found it necessary to introduce a covariance term. His estimate for the covariance is ·42 which, with estimates of ·17 and ·22 for the hereditary and environmental between family variances, means that the correlation between the family genotype and family environment should be $\cdot 42/2\sqrt{\cdot 17 \times \cdot 22} = 1\cdot 09$. Obviously there is something wrong somewhere. The writer suspects that the fault lies with the data. A tentative analysis of the data to be found in Newman *et al.* (1937) would suggest that covariance for attainment is probably no more than that for IQ. One must remember that attainment will be very much influenced by school factors—more so than IQ—and school factors are almost certainly correlated less with heredity than is the case for environmental home factors (generally regarded as the main environmental determinants of IQ).

COVARIANCE

It is surprising that anyone who adopts a hereditarian standpoint in respect of IQ should accept that covariance could be negligible. Even without statistical evidence, it seems obvious that parents of superior intellectual heredity will, on the average, provide superior intellectual environments for their children.

In any case, the statistical evidence is to be found in the foster child studies of Burks (1928a), Leahy (1935) and Freeman *et al.* (1928). Thus, in Table 12 of her monograph, Leahy presents the mean IQs and the mean Environmental Status Scores (ESS) of her foster and control children, classified according to the occupational status of the parents, foster in the one case and natural in the other. When these data are represented graphically, the results are as shown in Fig. 1. In the diagram, the fitted lines are the regression lines of IQ on ESS for the total groups of foster and control children.

It will be seen that the rate of increase of IQ with respect to ESS for the control children is about three times the rate of increase for the foster children. The explanation is fairly obvious. Whereas the increase in IQ of the foster children can be attributed only to an increase in the level of the environment (ignoring selective placement), the increase in IQ of the control children is due to an increase not only in the environmental level but also the genetic. Furthermore, since the genetic level, on the average, increases with the environmental level, it follows that there must be a fairly substantial measure of covariance between heredity and environment.

It also follows from Leahy's data that if one considers the differences in the mean IQs of (natural) children from different occupational levels, two-thirds of these differences can be attributed to heredity and one-third to environment.

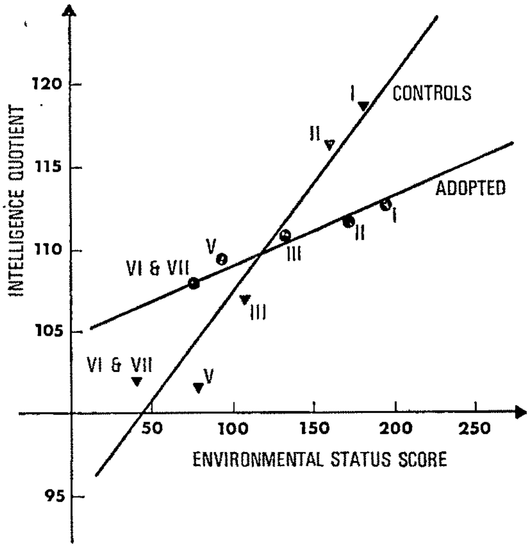
It was Burks (1938) who first realised the significance of Leahy's data and, reclassifying her own data (1928a) in the same way as Leahy had done, she obtained somewhat similar results.

At first sight, Freeman's study would appear to provide no evidence for covariance. This is due to the fact that, with adoption of the foster children taking place at an average age of 4 years 2 months, a considerable measure of selective placement was involved. Effectively, this meant a degree of covariance as great as that for natural children living with their parents. The result is that the rate of increase of IQ with Home Rating (Freeman's measure of environment) is just as great for the foster children as for normal children. However, in a re-analysis of the Freeman data,

FIGURE 1

Relationship between IQ and Environmental Status (E.S.) for Adopted and Control Children Classified According to Occupation of Father (Leahy 1935, Table 12)

(The occupational classes are those of Goodenough. I is professional, II business and managerial, III skilled trades, V semi-skilled, VI slightly skilled and VII day labour. Class IV (farmers) is not involved)



which by-passes the problem of selective placement, the writer has been able to show that, for the foster children, the true rate of increase of IQ with HR (Home Rating)—that is, if there were no selective placement—is about half that for normal children. This would mean that the average IQ difference between children from different occupational levels would be half heredity and half environment.

Further support for this proportion is provided by a re-analysis which the writer has carried out on the data contained in Appendix B of Jencks' book *Inequality* (Jencks *et al.*, 1972). Again the result obtained approached 50 per cent heredity and 50 per cent environment. Jencks' own analysis assigns only 30 per cent to heredity and as much as 70 per cent to environment, but it suffers from one or two serious weaknesses; in particular, it does not allow for genetic variation with age and ability (see section below).

What is the actual value for the covariance between heredity and environment? It can be shown that each of the foster child studies, Burks, Leahy and Freeman, provides a value for the covariance of 14-15 per cent of the total IQ variance (corrected for attenuation). Since this estimate is derived from such measures as Cultural Index (Burks), Environmental Status Score (Leahy) and Home Rating (Freeman), which are only approximate measures of the family environment, it is likely that the covariance term could be more than 14-15 per cent.

Jencks' study (1972) gives a figure of 18-19 per cent for the covariance. The method used was path analysis, but it is fairly easy to show that, as far as the derivation of the covariance is concerned, the procedure consists essentially of assuming that the genotypic value G for the child is correlated with its environment E, entirely through the IQs of the parents. In a revised version of the Jencks analysis, which will be described presently, the writer makes somewhat the same assumption—there is a correction for genetic variation with age—and, despite the fact that several changes were made to Jencks' statistics, he obtained the same figure of 18-19 per cent.

It would appear, therefore, that the covariance is at least 14-15 per cent of the total IQ variance (corrected) and could well be as high as 18-19 per cent.

JENCKS' STUDY

In the opinion of the writer, Jencks' analysis of the heredity-environment data for IQ (Appendix A, Jencks *et al.*, 1972) stands up well to a comparison with the work of the two schools of biometrical genetics already discussed. Admittedly, it can be faulted on the ground that it does not provide standard errors for the variance estimates it offers; in other words, it does not use the powerful statistical techniques employed by the two schools. On the other hand, it can be argued that Jencks' approach has features that more than compensate for the lack of statistical tests.

Mention has already been made of the fact that, in applying Maximum Likelihood or Least Squares, the two schools make no attempt to correct data for systematic factors (not included in the model) which might be operating. Consequently, although a particular genetic model might show a good fit to the data on applying a statistical test and also yield estimates of seemingly small standard error, there is always the danger that these high-powered statistical methods are failing to reveal systematic effects that are undoubtedly there. As a result the estimate of seemingly low standard error may actually have quite a large error attached to it.

A good example of this is to be found in Jinks and Eaves (1974), quoted also by Fulker (1974). The method of weighted least squares was applied both to Burt's (British) and to Jencks' (American) data. The fit of the genetic model was good in both cases. However, in the case of Burt's data, the environmental variance between families (E_2) comes out at ·07 ± ·02 and ·10 ± ·03, depending on which of two models is used; for Jencks' data, the estimate of E_2 is ·29 ± ·02. On the face of it, because of the high precision assigned to the estimates, the environmental differences between families in America are on the average considerably greater than for Britain. This is very doubtful. Even Jencks, who tends to err on the environmental side, does not put the environmental variance between American families higher than ·20. An obvious explanation for the high estimate which the British group derived from the Jencks data is selective placement, particularly marked in the Freeman foster child study. In other words, the apparent precision of the E_2 estimate for Jencks' data is almost certainly spurious.

One of the major virtues of Jencks' approach is that he tries to allow for a number of systematic factors in deriving his final estimates. These include covariance, selective placement of foster children, also the increase in the within pairs environmental variance as one goes from identical twins, through fraternal twins, to siblings. Concerning the last of these items, Jencks is particularly conscious of the considerable difference between the intraclass correlations for fraternal twins and siblings (·69 *vs.* ·57, when corrected). Such a difference is completely passed over in the analysis of Jencks' data by Maximum Likelihood and Weighted Least Squares, for the simple reason that Jencks' twins correlation was taken from the Newman *et al.* (1937) study; only 50 pairs of fraternal twins were involved and, as a result, the correlation does not differ significantly from that for siblings. However, as Kamin (1974, p. 83) points out, there are other studies which confirm the high correlation for fraternal twins vis-à-vis siblings.

The basis of Jencks' analysis is a path model linking the genetic and environmental components of parents and child (both natural and foster). His approach, therefore, represents a considerable shift from that of Burt's early work, when he relied mainly on data from identical twins. In this respect, Jencks was followed by the Hawaiian group; but he differs from them in that by making *g*, the path coefficient from parental to child genotype, one of the parameters of his model, he includes dominance in his model. In the latter respect, therefore, he can be linked with the British school.

Jencks' analysis also extends to a consideration of the correlations for unrelated children brought up together, and the usual kinship correlations such as those for siblings and fraternal twins. He found it virtually impossible to reconcile the data from all the different studies. In the end, he settled for the following solution to the heredity-environment problem: heredity, 45-50 per cent; environment, 30-35 per cent; and covariance, 18-19 per cent. The environmental variance is further analysed into about 20 per cent between families and about 15 per cent within families.

Despite the high quality of Jencks' study, it has several weaknesses. Firstly, although he makes allowance for selective placement in dealing with the foster child studies of Burks, Leahy and Freeman, he tends to accept the results of these studies somewhat uncritically. In particular, he makes the serious mistake of applying the same placement correction to the Freeman study as for the other two. As the writer has shown elsewhere, a gross degree of selective placement took place in the case of the Freeman study. The Jencks correction is therefore quite inadequate; and it required virtually a reconstruction of the Freeman study in order to obtain correlation estimates, free from the selective placement factor.

Secondly, there are two technical errors in the Jencks analysis. Thus, in his basic analysis, derived from a simple path model involving parents and child, he makes no distinction between natural child and foster child in his path coefficients from G_c and E_c to IQ_c. This is equivalent to overlooking the covariance term in his statistical model—rather surprising in Jencks who emphasises covariance. Also in his expression for the correlation between sibling (or fraternal twin) genotypes (Jencks, 1972, p. 303), he uses the correlation (p) between maternal and paternal genotypes as a substitute for Fisher's A, the correlation between their additive deviations (see Statistical Appendix).

Thirdly, Jencks' analysis makes no allowance for genetic variation with age. In this regard, it is no different from virtually every other analysis in the heredity-environment field; the only exceptions are analyses based on separated identical twins, where the age factor does not operate.

The principle of genetic variation with age is a new factor which the writer has introduced into the heredity-environment field. Its oversight tends to lead to an inflation of the environmental component at the expense of the hereditary. This is particularly marked in the case of Jencks, whose analysis depends very much on parent-child correlations and who (rightly) is prepared to recognise a significant difference between the correlation for fraternal twins and siblings.

Because of the importance of the principle and because it constitutes a primary feature of the writer's own analysis, the next section will be devoted entirely to its elucidation.

THE PRINCIPLE OF GENETIC VARIATION WITH AGE

In a sense, there is nothing new about the principle. It is basic to genetics and genetic psychology. The essential idea is that the genetic is not merely something which is fixed at conception but is a programme in time that unfolds with the individual's development. Also, at each stage, the genetic and the environmental interact. In fact, development is strictly the produce of the interaction. It follows that, for any developing individual, the genetic factors which operate at any one point in time are not the same as the genetic factors which operate at another point in time. Furthermore, they will vary with the aspect of development being considered. The genetic factors underlying one ability will differ from the genetic factors underlying another ability, even when the abilities are measured at the same age. Expressed in statistical terms, this means that the genotypic value G for an individual will vary from age to age and ability to ability. In other words, it is a function of age and ability. Only at maturity might a person's G for any one ability be assumed constant, although even this statement has to be qualified, since genetic factors will underlie the ageing process and therefore it is reasonable to suppose that G will vary also during senescence.

The remarkable thing is that the principle of genetic variation with age has been completely ignored by the statistical geneticist, psychologist and sociologist. In every case, the genotypic value G for the individual in respect of a given ability is taken as fixed for all ages. There is also more than a tendency to regard G as being the same from ability to ability. In the case of an IQ test such as the Stanford Binet, we can be more specific about how G will vary. Thus, the difference between G at any age x, where $x<16$, and G at age 16 will increase with the difference in the two ages. Also, just in the same way as the correlation between IQ at age x ($x<16$) and IQ at 16 increases with x and reaches one when $x=16$, so will the correlation between G_{IQ} at age x and G_{IQ} at 16. In fact, as the writer has shown, most of the so-called ' inconstancy of IQ ' can be attributed not so much to environmental change over the years of development as to the change in G. In the case of a Binet test, this should be fairly easy to understand and accept, since it is well recognised that its factor content varies with age.

None of the standard methods of analysis, correlation analysis, biometric-genetic analysis, MAVA (Multiple Abstract Variance Analysis) or path analysis, makes allowance for genetic variation with age. Thus, in the case of correlation and biometric-genetic analysis, it is wrongly assumed that correlations such as parent-child and sibling-sibling are independent of the ages of the children concerned. A similar mistake is made in MAVA where it is assumed that the hereditary variances between and within sibling pairs are independent of the age differences between the pair members, and therefore, in the extreme case, can be taken to be the same as for fraternal twins.

It follows from the genetic variation principle that the parent-child and sibling-sibling correlations are a function of the ages of the children. Thus, the younger the children, the greater the dissimilarity between the Gs of the children on the one hand and the Gs of the parents on the other, and therefore, the smaller the parent-child correlation. Similarly, the greater the difference in age between siblings, the greater the difference in their G-values and again, the smaller the correlation. In particular it follows that the correlation between siblings must of necessity be less than the correlation between fraternal twins, irrespective of greater within family environmental differences in the case of siblings.

Because of the depression in value of parent-child and sibling-sibling correlations as a result of genetic variation with age, the standard methods of analysis, by making no allowance for this factor, will normally produce results in which the environmental variance is inflated at the expense of the genetic. This applies, in particular, to Jencks' analysis.

The problem of genetic variation does not arise in the case of analyses based on separated identical twins, since there is no age difference for a twin pair. This explains why Burt's earlier analyses, despite the failure to cope with the covariance term, give a better estimate of the environmental variance than does Jencks' analysis.

In the light of what has been said, it will be seen that the principle of genetic variation with age has two implications for heredity-environment analysis:—

(*a*) The genotypic value G has to be defined for population, ability (e.g. IQ test) and also age of measurement of that ability.

(*b*) Equation (1) can no longer be taken as the basic model for analysis. In order to allow for the age factor, the equation must now be written

$$IQ_t = G_t + E_t \qquad (5)$$

where the suffix *t* shows that G, as well as IQ and E, varies with time.

In applying any of the standard methods, it will now be necessary either to confine one's analysis to data of the same age level, or to adjust data obtained from different levels, so that one is effectively dealing with data at the same level. This is fairly easily done in the case of all the standard methods.

At first sight, it might appear that the modification required must lead to a considerably greater degree of complexity in the analysis, and also render the task of collecting suitable data even more difficult than it has been in the past. The problem, however, is greatly simplified, if one makes the assumption, discussed earlier, that the proportions of the IQ variance due to heredity and environment remain more or less the same for all ages, at least, say, from 5 years onwards.

A final point: due recognition of the other aspect of the genetic variation principle, i.e. that G varies from ability to ability, is also important. Thus, failure in this regard underlies most of the confusion in the past centering around the relationship between IQ test results and scholastic performance (e.g. reading). Concepts like retardation, underfunctioning, minimal learning disability, and so on, all require re-thinking.

THE NEW SOLUTION

It is not possible here to give a complete account of the writer's own analysis, but the equations involved are set out in the Statistical Appendix. The writer followed Jencks in making the correlations between parents and offspring (both natural and foster) basic to the whole analysis. The only other correlation of equal importance is that for fraternal twins. The main difference from Jencks is the incorporation of the principle of genetic variation with age into the analysis. This meant the abandonment of the method of path analysis, employed by Jencks, and the use of a more basic approach (Expected Values). Also, as was indicated in the last section, it meant that the final analysis had to be carried out on data (or estimates) which all belonged to the same age level. The age level chosen was 16, generally regarded as the point of intellectual maturity for the average person. (There is, of course, the basic underlying assumption that the data at age 16 give results which apply also to other ages.)

The use of Expected Values does not in itself provide an estimate of covariance. In Jencks' case, the estimate of covariance follows from his path model, but since the method of path analysis was not employed by the writer, it might appear that some alternative solution is required. However, as was pointed out in the section on covariance, Jencks' procedure is equivalent to assuming that the child's G-value is correlated with his environment entirely through the IQs of the parents. The same assumption was adopted in the writer's own analysis, with the modification that the G-value of the child had to be at the same age level as that of the parents (i.e. 16). The result is an expression for the covariance (see equation (7) in Appendix) which depends mainly on two correlations: (*a*) the correlation between the IQs of foster parent and foster child (no selective placement) and (*b*) the correlation between the

IQ of the natural parent and the IQ of the natural child (at age 16). A justification for making this assumption is that it yields estimates for the covariance consistent with those to be obtained directly from foster child studies.

The correlation (*a*) proves to be an important element throughout the whole analysis. In order to obtain an estimate of its value, all four of the classical foster child studies were used. In the case of Burks (1928) and Leahy (1935), little more was involved than applying a correction for selective placement. As indicated earlier, the same approach could not be adopted with Freeman's study (1928); a complete reanalysis was required. The result was an estimate (·20) which differed little from the Burks and Leahy figures.

The Skodak and Skeels (1949) study does not offer any correlations between foster child and foster parent. But it is unique in that it provides correlations between the IQs of the foster children, as measured at four different stages and the IQs of the natural mothers. This feature is highly important for the writer's analysis since it provides a measure of genetic variation with age. A more immediate consequence is that, by means of equations given in the Appendix, a fourth estimate of the correlation between the IQs of the foster child and foster mother can be obtained. The estimate is ·226.

The average of the estimates from the four foster child studies is ·20. By means of the equations given in the Appendix, this figure can be used to apply a correction for sampling error to the Skodak and Skeels data (in addition to the correction for selective placement). As a result, one obtains an estimate of the correlation between the IQ of the foster child at age 16 and the IQ of the natural mother and hence, by means of the Appendix equations, an estimate of the IQ correlation between the natural parent and child living together (the child's age again being 16). The second of these estimates is ·585 (·035 more than the average of ·55 which Jencks obtains over a number of parent-child studies). Having estimates of the two correlations, foster child *vs.* foster mother and natural child *vs.* natural mother, one can then derive an estimate of the magnitude of the covariance. The result is a figure of ·186 (18·6 per cent).

As in Jencks' analysis, the complete solution to the heredity-environment problem requires the determination of four unknowns, h, e, s and g, where h^2 and e^2 are the hereditary and environmental components of the IQ variance and $2hes$ is the covariance term, s being the correlation between G and E. (g has already been defined. As explained earlier, it provides an estimate of dominance, $(1-2g)$ being the fractional contribution of the latter to the genetic variance.)

The basic equation $h^2+e^2+2hes=1$, the estimate for $2hes$ and the correlation between parent and child (age 16) yield 3 equations for the determination of the unknowns. A fourth is required. The equation chosen was that for the correlation between the IQs of fraternal twins (see equation (11) in Appendix). In choosing this correlation rather than the correlation for ordinary siblings, one avoids the problem of genetic variation with age.

As noted in the Appendix, the expression used for the correlation between the G-values of fraternal twins is different from that of Jencks, thus correcting one of Jencks' technical mistakes.

An assumption involved in the writer's expression for the fraternal twins correlation is that the environmental variance within twin pairs is only ·04, i.e. not much more than the ·03 usually accepted for identical twins. The writer's justification for the choice of this figure would be that (*a*) fraternal twins are often treated very much the same as identicals, (*b*) the figure of ·04 yields results consistent with separated identical twins studies, even when a fair measure of selective placement is attributed to such studies.

Kamin (1974, p. 99), on the basis of a number of studies involving fraternal twins of like and opposite sex, would argue that the environmental variance within fraternal twin pairs is considerably more than the figure chosen by the writer. But the results to which Kamin refers are very easily explained on a genetic hypothesis, namely that the genetic variance for males is greater than that for females. Thus the Scottish Mental Surveys of 1932 and 1947 indicate a substantial difference in the IQ variance for boys and girls (about 30 points). It is very difficult to see this as an environmental difference. (As will be seen later, the IQ variance within separated identical twin pairs is only about 38 points. It is also interesting to note that a necessary consequence of this hypothesis is that the solution to the heredity-environment problem should be somewhat different for the two sexes, with hereditary differences playing a bigger part in the case of males.)

According to the final solution, the IQ variance can be divided up into the following components: heredity, 60·7 per cent; environment, 20·7 per cent; and covariance, 18·6 per cent. For those who are interested in the genetic architecture, the Appendix also provides the proportions of the genetic variance to be attributed to additive effects, dominance and assortative mating.

The solution might be seen as a compromise between Burt and Jencks. It agrees with Jencks in his assessment of covariance. But, as far as the relative importance of the hereditary and environmental components is concerned, the solution is much closer to Burt. For the writer's analysis, the ratio of the two components is about 60 : 20, or 75 : 25 (a figure usually associated with Jensen). Burt's estimate of the ratio is about 80 : 20, and that of Jencks is about 60 : 40.

CONSISTENCY OF THE PROPOSED SOLUTION WITH OTHER STUDIES

Any solution, in order to be acceptable, must be shown to be consistent with the data in the field and, where there appear to be disagreements, these must be resolved in one way or another.

Since the justification for the estimate of covariance was dealt with in an earlier section, the task now is to show that the estimate of the environmental component of the IQ variance (20 per cent), as provided by the new solution, can be reconciled with the data of other studies. Before we can proceed to do so, it is necessary to give some idea of how that 20 per cent should be divided up between the two subcomponents, the environmental variances between and within families.

In the analysis, described in the last section, it will be remembered that ·04 (i.e. 4 per cent) of the total IQ variance was ascribed to the environmental variance within fraternal twin pairs. The question now is: what is the environmental variance within *sibling* pairs? Obviously, if one accepts that the intraclass correlation for fraternal twins is ·69 and that for siblings it is only ·57, it seems reasonable to assume that a considerable part of the difference (12 per cent) can be attributed to greater environmental differences in the case of siblings. This, in fact, was the line followed by Jencks, the result being a fairly high estimate for the siblings environmental variance within families (about 15 per cent).

The principle of genetic variation with age is, however, relevant here. Because of the differences in age in the case of siblings, the differences between their G-measures will (on the average) be greater than those for fraternal twins. This will result in a lowering of the siblings correlation vis-à-vis the correlation for the twins. Without knowing the ages of the siblings involved in the calculation of intraclass correlations, it is difficult to assess how much of the difference between the siblings and fraternal twins correlations can be attributed to genetic variation with age. According to tentative calculations of the writer, this might amount to 4-6 per cent of the total IQ variance.

Another factor contributing to the difference between the two correlations (also considered by Jencks) is the age-to-age variation of the standardisation of the Binet test, in particular the Stanford Binet. This could account for another 1-3 per cent.

There would still be left about 5 per cent for the difference in the environmental variance within fraternal twin pairs and within sibling pairs. That is, the environmental variance within sibling pairs (or within families) would amount to $4+5=9$ per cent of the total IQ variance. It follows that $20{\cdot}7-9$ or some 12 per cent of the IQ variance could be attributed to the environmental variance *between families*. The next problem is to decide whether a figure of 12 per cent is sufficient to explain between families environmental differences.

Foster Child Studies

Most of the data for between family environmental differences come from the classical studies of Burks (1928a), Leahy (1935) and Freeman (1928).

The Leahy study. This study differs from the other two in that it yields a low estimate for between family differences. The correlations between the IQs of Leahy's foster children and her environmental measures do not exceed ·25, when all possible corrections are made. This would suggest a figure of no more than 5 per cent for the between families environmental variance.

The Burks study. Burks obtained a correlation of ·29 between foster child IQ and Cultural Index of foster home, after correction for attenuation. There should also be corrections for selective placement and restriction in range; however, since these have opposite effects it shall be assumed, for simplicity, that they cancel each other out. A correlation of ·29 yields a figure of about 7 per cent for the between families variance. This presents no serious problem as far as the proposed 12 per cent figure is concerned.

A major difficulty with Burks' study is that she proceeded to carry out a multiple correlation analysis between the foster child IQs on the one hand and the environmental variables on the other. As a result, she obtained a multiple correlation of ·42 (corrected for attenuation), which would suggest a figure of 17·6 per cent for the between families environment variance. This figure has never been challenged. For example, it was accepted by Shuttleworth (1935) and even by Jensen (1969). However, in a re-examination of the Burks' study, the writer has been able to show that her estimate is too high. The over-estimation is attributable to two factors: (*a*) errors in her basic data, in particular her low correlation (·09) between foster child IQ and foster father IQ, and (*b*) her use of multiple regression, a technique which capitalises on errors in correlation. If one omits the correlation for the foster father's IQ from the regression analysis, the estimate for the environmental variance between families is immediately reduced to 10·5 per cent. Also, there is further reason for believing that the figure is less than 10·5 per cent, in fact probably not much more than the 7 per cent to be obtained by using only the correlation for the Cultural Index.

It might also be noted in passing that Shuttleworth's study (1935), based on Burks', is quite invalid, although the solution he offers appears reasonable. Shuttleworth made two mistakes. Not only did he accept the results of Burks' multiple correlation analysis as valid, but he assumed (wrongly) that the multiple correlation between the IQs of the control children and the environmental measures is the same thing as the correlation between the IQs and E_S, the (systematic) measure for the family environment as a whole. The second mistake, in a way, compensated for the first and thus gave an apparently acceptable final solution.

The Freeman study. The Freeman study has always been a favourite with the environmentalist looking for evidence of large environmental effects. Thus, one of

Freeman's main statistics is the correlation of ·48 between foster child IQ and Home Rating (HR). A figure of this size implies a between family environmental variance of more than 20 per cent.

Since Freeman's foster children were not adopted until an average age of 4 years 2 months, it can easily be argued that the high correlations obtained were due to selective placement of the children (cf. Burks, 1928b). This explanation, however, was opposed by Freeman and, more recently, by Kamin (1974). In the writer's re-analysis of Freeman's data, estimates of the mean HRs of the natural homes of the foster children were derived and also their mean IQs if they had stayed in these homes. Then, taking the ratio of the mean gain in IQ to the mean difference in HR, in going from natural home to foster home, it was possible to obtain a measure of the ' true ' correlation between foster child IQ and HR (i.e. with the factor of selective placement eliminated). This correlation proved to be ·295, about the same figure as was obtained in the Burks study.

Freeman's Home Rating, like Burt's Cultural Index and indeed all such indices, would appear therefore to indicate an environmental variance between families of the order of 7 per cent. The question now arises: how does one explain the low figure of 7 per cent produced by the foster child studies vis-à-vis the 12 per cent derived from the writer's analysis?

An obvious explanation is that such indices as Home Ratings do not measure all the factors that are involved in between family environmental differences. Some evidence of this emerges from the writer's re-analysis of Freeman. It would appear that Home Ratings do not provide an adequate coverage of the emotional, motivational or attitudinal aspects of the home environment. These could well account for another 4-5 per cent of IQ variance, the difference between 7 per cent and the 12 per cent derived above.

Twin Studies

A consideration of the data from twin studies has been left to the last, probably in view of the opposition they have always received. It is also the writer's opinion that much of the criticism of Burt stems from his identification with these studies. As will now be shown, the data from twin studies are quite respectable and reasonably consistent with the results that have already been presented.

Only two studies of separated identical twins will be considered: the NFH study (Newman, Freeman and Holzinger, 1937) and Burt (1956).

It is most unfortunate that twin data are usually presented in the form of intraclass correlations. The latter can be expressed in the form:

$$r \text{ intraclass} = \frac{\text{variance between twin pairs}}{\text{total twin variance}} \tag{6}$$

or

$$r \text{ intraclass} = 1 - \frac{\text{variance within twin pairs}}{\text{total twin variance}} \tag{7}$$

Obviously, the correlation depends on two variances, (*a*) the variance within twin pairs and (*b*) the total twin variance. Consequently, it will vary not only with sampling error in respect of (*a*) but also error in respect of (*b*). Furthermore, since studies of separated identical twins involve small numbers, the (*b*) variation can be considerable as is shown by the lack of agreement between studies as far as total twin variance is concerned. Clearly, the simple solution to the problem is not to bother with intraclass correlations but to concern oneself only with variances—in particular the variance within twin pairs—and then, if one wants to convert to a correlation, one can do so by using an agreed figure for the total twin variance.

Kamin (1974) clouds the issue with (*a*) his criticism of McNemar for adjusting the NFH correlations to a common total variance and (*b*) emphasising the dependence of twin correlations on the age factor. (The latter has nothing to do with the earlier principle of genetic variation with age but concerns only the variation in the standardisation of the Stanford Binet from age to age.) By dealing only with the variance within twin pairs, both these criticisms become irrelevant.

If there is no selective placement (the case of selective placement will be dealt with presently), the variance within pairs for separated identical twins is a measure of the total environmental variance. This fact alone explains Burt's insistence on the importance of identical twin studies for the heredity-environment problem.

In the case of the NFH study, the variance within twin pairs, corrected for error, is 36·3. If we assume that the total IQ variance is $15^2=225$ (corrected for error), it follows that the total environmental variance is 16·2 per cent of the total variance.

When one turns to Burt's data, the situation is a little more complicated. Since his adjusted assessments are unacceptable, use will be made only of the group test correlation that he obtained for his separated identical twins (·77). When this is converted to a variance within pairs and the correction for error applied, the figure obtained is 38·0, which is 16·9 per cent of the total variance (225).

The agreement between Burt and the NFH study could not be much better and both estimates are not far short of the figure provided by the writer's own solution (20·7 per cent).

There remains the vexed question of selective placement. This has always been the main argument used by critics against the separated identical twins type of research. Burt's counter-argument was that there was virtually no correlation between the socio-economic backgrounds of his separated twin pairs. An important point to note, which tends to be overlooked, is that selective placement involves only between families environmental differences; it is difficult to see how it would affect within families differences. Consequently, within the limits of sampling error, the variance within separated identical twin pairs must consist of the full amount of environmental variance within families plus a fraction of the environmental variance between families, depending upon the degree of selective placement that is operating.

According to the writer's analysis, the environmental variance within families is about 9 per cent. Subtracting this from 16-17 per cent (the figure that emerges from the NFH study and Burt's data), one is left with about 7-8 per cent. Obviously, the writer's solution (12 per cent) is quite consistent with the identical twins studies, even where one wants to recognise a considerable amount of selective placement in these studies. According to these figures, selective placement would, in fact, be producing a reduction of as much as one-third of the total between family environmental variance. It is very doubtful whether the figure could be much more.

CONCLUSION

The article began with Burt and concludes with Burt. The researches which the writer has carried out, involving both the application of the principle of genetic variation with age and a re-analysis of the earlier studies from which most of the data are derived, would suggest that Burt was not so far from the truth in his analysis of the variance of measured intelligence. His biggest mistake is to be found in his handling of the covariance component. In the end he just abandoned it completely. In this respect, he was no different from others, e.g. Jinks and Fulker (1970).

As far as the ratio of the hereditary variance to the environmental variance is concerned, the writer's own analysis supports a figure of 75 : 25, which does not differ to any great extent from that of Burt (80 : 20). In fact, the figure of 75 : 25 is often associated with both Burt and Jensen. In the writer's analysis, the application of the principle of genetic variation with age played an important part in producing the result. Burt, on the other hand, largely avoided the problem of genetic variation by concentrating on twin studies where the age factor does not operate. The same cannot be said for the other types of study.

The writer's own impression is that Burt's intuitions in respect of the heredity-environment problem were on the whole much sounder than those of many of his critics. Also, one must make allowance for the fact that he was a pioneer in the study of the heritability of IQ; most of the more sophisticated analyses in the field came after his early work. One might go further and say it was unfortunate that he embarked on heredity-environment analysis only after he had reached his seventieth year, for there is little doubt that in his old age his statistical powers, although still formidable, were rather less than they had been forty years or so earlier, when he contributed so much to the development of factor analysis. Even if he was guilty of misuse of data, this does not justify any attempt to pull down the whole edifice for which he stood. It would be hoped that the present study has shown that the latter is securely based with or without Burt's own contribution.

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STATISTICAL APPENDIX

NOTE:—As in Jencks' analysis, the error component has been removed from the environmental variance (e^2) and all correlations are corrected for attenuation.

1. *Basic Equations*

For natural children, living with their own parents,

$$\mathrm{IQ}(x) = h\mathrm{G}(x) + e\mathrm{E}(x) \tag{1}$$

where x = CA of child and IQ, and the genotypic and environmental values G and E are standardised (mean 0 and SD 1).

It follows that

$$1 = h^2 + e^2 + 2hes \tag{2}$$

where $2hes$ is the covariance term, s being the correlation between G and E.

For foster children (no selective placement),

$$\mathrm{IQ}(x) = [h\mathrm{G}(x) + e\mathrm{E}(x)] \,/\, \sqrt{h^2+e^2} \tag{3}$$

The same equation applies approximately when there is moderate selective placement (as in Burks, Leahy, and Skodak and Skeels studies).

2. *Derived Equations*

It will be appreciated that space does not permit the setting out of all the assumptions involved. A basic assumption, however, which should be stressed, is that the values of h^2, e^2 and $2hes$ are approximately the same for all ages, say from 5 onwards, including adulthood.

(a) *The correlation between adopted child (AC) and adopting parent (AP) in the case of no selective placement (NSP).*

$$(r_{\mathrm{IQ}_{\mathrm{AC}}\mathrm{IQ}_{\mathrm{AP}}})_{\mathrm{NSP}} = (e\, r_{\mathrm{E}_{\mathrm{NC}}\mathrm{IQ}_{\mathrm{NP}}}) \,/\, \sqrt{h^2+e^2} \tag{4}$$

where NC and NP denote natural child and parent. (It is assumed that this correlation is independent of CA of child.)

(b) *The correlation between natural child (NC) and natural parent. (The formula is written in terms of NM.)*

$$r_{\mathrm{IQ}_{\mathrm{NC}(x)}\mathrm{IQ}_{\mathrm{NM}}} = h\, r_{\mathrm{G}_{\mathrm{NC}(x)}\mathrm{IQ}_{\mathrm{NM}}} + \sqrt{h^2+e^2}(r_{\mathrm{IQ}_{\mathrm{AC}}\mathrm{IQ}_{\mathrm{AM}}})_{\mathrm{NSP}} \tag{5}$$

For $x = 16$,

$$r_{\mathrm{IQ}_{\mathrm{NC}(16)}\mathrm{IQ}_{\mathrm{NM}}} = gh(h+es)\,(1 + r_{\mathrm{IQ}_{\mathrm{NF}}\mathrm{IQ}_{\mathrm{NM}}}) + \sqrt{h^2+e^2}(r_{\mathrm{IQ}_{\mathrm{AC}}\mathrm{IQ}_{\mathrm{AM}}})_{\mathrm{NSP}} \tag{6}$$

where g is the path coefficient between $\mathrm{G}_{\mathrm{NC}(16)}$ and G_{NM} (or G_{NF}), and $r_{\mathrm{IQ}_{\mathrm{NF}}\mathrm{IQ}_{\mathrm{NM}}}$ is the correlation between the IQs of the natural parents. (It is assumed that at 16 the child reaches maturity and his G belongs to the same age level as that of his parents.)

(c) *The covariance 2hes.* Since it is assumed that $2hes$ is the same for all ages, it is sufficient to derive its value for $x = 16$. Following Jencks, it is assumed that $\mathrm{G}_{\mathrm{NC}(16)}$ is correlated with $\mathrm{E}_{\mathrm{NC}(16)}$ entirely through the IQs of the parents. It follows that

$$2hes = \frac{4\sqrt{h^2+e^2}(r_{\mathrm{IQ}_{\mathrm{AC}}\mathrm{IQ}_{\mathrm{AP}}})_{\mathrm{NSP}}}{1 + r_{\mathrm{IQ}_{\mathrm{NF}}\mathrm{IQ}_{\mathrm{NM}}}} \left[r_{\mathrm{IQ}_{\mathrm{NC}(16)}\mathrm{IQ}_{\mathrm{NP}}} - \sqrt{h^2+e^2}(r_{\mathrm{IQ}_{\mathrm{AC}}\mathrm{IQ}_{\mathrm{AP}}})_{\mathrm{NSP}} \right] \tag{7}$$

(d) *Corrections for selective placement* (*SP*).

$$\left(r_{\mathrm{IQ}_{\mathrm{AC}}\mathrm{IQ}_{\mathrm{AM}}}\right)_{\mathrm{NSP}}=\left(r_{\mathrm{IQ}_{\mathrm{AC}(x)}\mathrm{IQ}_{\mathrm{AM}}}\right)_{\mathrm{SP}}-\frac{h}{\sqrt{h^2+e^2}}\,r_{\mathrm{G}_{\mathrm{NC}(x)}\mathrm{IQ}_{\mathrm{NM}}}\,r_{\mathrm{IQ}_{\mathrm{NM}}\mathrm{IQ}_{\mathrm{AM}}} \tag{8}$$

$$\left(r_{\mathrm{IQ}_{\mathrm{AC}(x)}\mathrm{IQ}_{\mathrm{NM}}}\right)_{\mathrm{NSP}}\left[=\left(h\,r_{\mathrm{G}_{\mathrm{NC}(x)}\mathrm{IQ}_{\mathrm{NM}}}\right)/\sqrt{h^2+e^2}\right]$$

$$=\left(r_{\mathrm{IQ}_{\mathrm{AC}(x)}\mathrm{IQ}_{\mathrm{NM}}}\right)_{\mathrm{SP}}-\left(r_{\mathrm{IQ}_{\mathrm{AC}}\mathrm{IQ}_{\mathrm{AM}}}\right)_{\mathrm{NSP}}\,r_{\mathrm{IQ}_{\mathrm{NM}}\mathrm{IQ}_{\mathrm{AM}}} \tag{9}$$

The negative terms on the RH sides of equations (8) and (9) are the correction terms. (Because of the interdependability of the various equations, a reiterative method has to be employed in carrying out the analysis.)

(e) *The intra-class correlation between fraternal twins.* (This correlation was chosen for the purpose of the analysis, since the G-values of the twins belong to the same age level. This is not the case for ordinary siblings where the G-values belong to different age levels.)

$$r_{\mathrm{IQDZT}}=h^2\,r_{\mathrm{G}_1\mathrm{G}_2}+2hes+e^2\,r_{\mathrm{E}_1\mathrm{E}_2}$$

Applying Fisher's genetic model,

$$r_{\mathrm{G}_1\mathrm{G}_2}=\cdot 25+\cdot 5g+2g^2p \tag{10}$$

where p is the correlation between the genotypes of spouses. (Fisher's A, which is the correlation between the additive deviations of spouses, is given by $\mathrm{A}=2gp$. Equation (10) differs from the equation in Jencks (1972, p. 303) where the last term is given simply as gp, i.e. Jencks treats p as equivalent to A.)

If we assume that $r_{\mathrm{E}_1\mathrm{E}_2}=e^2-\cdot 04$ and, as in Jencks, that $p=(h+es)^2\,r_{\mathrm{IQ}_{\mathrm{F}}\mathrm{IQ}_{\mathrm{M}}}$, it follows that

$$r_{\mathrm{IQDZT}}=h^2\left[\cdot 25+\cdot 5g+2g^2(h+es)^2 r_{\mathrm{IQ}_{\mathrm{F}}\mathrm{IQ}_{\mathrm{M}}}\right]+2hes+e^2-\cdot 04 \tag{11}$$

3. *The Basic Data*

(*a*) The foster child studies Burks, Leahy, Freeman, and Skodak and Skeels. The Skodak and Skeels study is particularly important in that it provides data from which one can derive a curve showing the variation of $r_{\mathrm{IQ}_{\mathrm{AC}(x)}\mathrm{IQ}_{\mathrm{NM}}}$ (and $r_{\mathrm{G}_{\mathrm{NC}(x)}\mathrm{IQ}_{\mathrm{NM}}}$) with CA($x$).

(*b*) Correlations taken mainly from Jencks, in particular

$$r_{\mathrm{IQ}_{\mathrm{NF}}\mathrm{IQ}_{\mathrm{NM}}}=\cdot 57 \qquad r_{\mathrm{IQDZT}}=\cdot 692$$

and

$$r_{\mathrm{IQ}_{\mathrm{NC}(x)}\mathrm{IQ}_{\mathrm{NP}}}=\cdot 55\ (x<16,\text{ say }9\cdot 3,\text{ the mean age for the Leahy study}).$$

4. *The Analysis*

(*a*) $\left(r_{\mathrm{IQ}_{\mathrm{AC}}\mathrm{IQ}_{\mathrm{AM}}}\right)_{\mathrm{NSP}}$

In the case of Burks and Leahy, estimates were obtained from equations (8) and (9), following application of reiterative method. The two estimates were ·168 and ·180.

In the case of Freeman, a complete reconstruction of the study was required in order to allow for selective placement. The estimate obtained was ·20.

The Skodak and Skeels study also involved a lengthy analysis. Use was made of (i) the correlation $r_{\mathrm{IQ}_{\mathrm{NC}(9\cdot 3)}\mathrm{IQ}_{\mathrm{NM}}}$ (ii) equations (5) and (9) and (iii) the curve giving the variation of $r_{\mathrm{IQ}_{\mathrm{AC}(x)}\mathrm{IQ}_{\mathrm{NM}}}$ with CA(x). The estimate produced was ·226.

The mean of the four estimates is ·20 (approx.).

(*b*) $r_{\mathrm{IQ}_{\mathrm{NC}(16)}\mathrm{IQ}_{\mathrm{NP}}}$ and $2hes$.

Using the mean estimate of ·20 for $\left(r_{\mathrm{IQ}_{\mathrm{AC}}\mathrm{IQ}_{\mathrm{AM}}}\right)_{\mathrm{NSP}}$ and applying the Skodak and Skeels analysis in reverse, one obtained the following estimates

$$r_{\mathrm{IQ}_{\mathrm{NC}(16)}\mathrm{IQ}_{\mathrm{NP}}}=\cdot 585\text{ and }2hes=\cdot 186 \tag{12}$$

It follows from equation (6) that

$$gh(h+es)\left(1+r_{\mathrm{IQ}_{\mathrm{NF}}\mathrm{IQ}_{\mathrm{NM}}}\right)=\cdot 405 \tag{13}$$

(*c*) *The Solution*

The equations (2), (11), (12), and (13) contain only 4 unknowns g, h, e, and s.

On solution, one obtains $g = \cdot 368$, $h^2 = \cdot 607$, $e^2 = \cdot 207$ and $s = \cdot 263$.

That is, the IQ variance consists of the following components: heredity 60·7 per cent, environment 20·7 per cent and covariance 18·6 per cent (error having been removed in the first place).

Since $p = (h + es)^2\, r_{\mathrm{IQ}_{\mathrm{NF}}\mathrm{IQ}_{\mathrm{NM}}} = \cdot 460$, it follows that Fisher's $\mathrm{A} = 2gp = \cdot 339$.

The hereditary variance can therefore be analysed into the following three components:—

The additive component $= 2g(1 - \mathrm{A}) = \cdot 487$ (48·7 per cent).
Dominance $= 1 - 2g = \cdot 263$ (26·3 per cent).
Assortative mating $= 2g\mathrm{A} = \cdot 250$ (25 per cent).

(The corresponding values for Fisher's $\mathrm{D_R}$ and $\mathrm{H_R}$ are ·973 and 1·05 respectively.)

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WHEN DO FIRST LETTER MNEMONICS AID RECALL?*

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SUMMARY. First letter mnemonics are popular but they have failed to improve recall in several studies. In Experiment I the effectiveness of experimenter and subject generated mnemonics and concrete and abstract mnemonic words were compared using a sample of 30 undergraduates. There was no improvement in recall. It was hypothesised that the general failure of experimental studies of the mnemonic may result from the use of unrelated words as learning material. The mnemonic may help retain order but not aid retrieval. In Experiment II, when a random ordering of the days of the week had to be retained, first letter mnemonics considerably improved recall among a sample of 36 undergraduates. The mnemonic does, therefore, aid recall when the items are known but their ordering presents problems.

INTRODUCTION

LEARNING is easiest when the information to be retained is meaningful and can be easily assimilated into the existing knowledge structure of the learner. Consequently, most teaching techniques attempt to build through the understanding and comprehension of the pupil. There are, however, situations in which the information to be acquired has little or no logical structure. The order of the colours of the rainbow and the lengths of the months of the year are two examples where there is no underlying logic to be grasped. Other situations, such as the remembering of complex formuli, may not be greatly aided by knowledge of the derivation of the information. The use of mnemonics has traditionally provided a method for dealing with such situations. Throughout life, it will sometimes be necessary to learn apparently unconnected information and a knowledge of what techniques to apply to simplify and quicken the task should be one element of education.

Among mnemonic techniques, those incorporating the first letters of the items to be learned into easily remembered words or sentences are among the best known and the most frequently adopted. These mnemonics can take the form of sentences when the first letters of the items to be remembered form the first letters of a sentence, as when ' Richard of York Gave Battle In Vain ' is used to retain the order of the colours of the rainbow. Alternatively the first letters are formed into words, so, for example, ' CLOD ' can be used to remember the shades of blue of the Oxbridge Universities (Cambridge, Light, Oxford, Dark). There seems to be a widely held confidence in the effectiveness of these mnemonic techniques. Blick *et al.* (1972) reported that the first letter mnemonic technique was the one most likely to be adopted by college students asked to learn long serial lists of words. Gruneberg (1973) found that the first letter mnemonic was the technique most commonly used by students revising for finals.

The evidence for the popularity of the first letter mnemonic contrasts surprisingly with the evidence for its effectiveness. Most of the other common mnemonic techniques such as the formation of images, stories and rhymes have been demonstrated to lead to considerable improvement in recall (Morris, 1977). However, several studies have failed to find an improvement in memory when first letter mnemonics are employed. Gruneberg (1973) found no relationship between the use of the mnemonic technique and the class of degree obtained by university students. Boltwood and Blick (1970) failed to find an improvement, when subjects generated their own first letter mnemonics words to learn 19 unrelated items. Waite *et al.* (1971) also found no improvement in recall when subjects used the first letter mnemonic even when the subjects were selected on the basis of their claim that they would ordinarily use the first letter technique.

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* The results of these experiments were reported at the British Psychological Society Conference, Exeter, 1977.

A study which has shown positive results for the first letter mnemonic is that by Nelson and Archer (1972). They had subjects learn six lists of six words, and tested recall after each list had been presented. Half the subjects received conventional serial learning instructions. Prior to each list, the other subjects were verbally given a word made up of the first letters of the list. The mnemonic group who received the mnemonic word at the initial presentation showed about 18 per cent fewer errors than control subject. When recall, irrespective of correct position, was assessed the mnemonic group were no better than the control group. Nelson and Archer's results do, therefore, offer some support for the first letter mnemonic. Their design could have been improved to allow the mnemonic more opportunity to reveal any effects. The immediate testing of recall of the lists was likely to favour retention at only a superficial level of encoding (Gotz and Jacoby, 1974; Lockhart *et al.* 1976).

The evidence for the effectiveness of the first letter mnemonic technique is, therefore, confused. There are at least three studies showing no effect, and one where an improvement in recall occurred. The present paper reports two experiments which attempted to locate the conditions under which the first letter mnemonic is effective. The first experiment was similar in some ways to that of Nelson and Archer, in that subjects learned six lists of unrelated words. However, to strengthen the benefit of the mnemonic, recall of the lists was not required until all six lists had been presented. In addition, two other variables were included. The power of subject-generated mnemonics was compared to experimenter-provided mnemonics since this distinction is known to be important when sentences are used as mediators to aid learning. Where the experimenter provided the mnemonics, the concreteness of the mnemonic word was also manipulated, since concrete nouns are usually better recalled than abstract nouns (Paivio, 1971).

EXPERIMENT I

METHOD

Subjects

Thirty undergraduates at Lancaster University volunteered to act as subjects, and were tested either individually or in pairs.

Materials

Six lists of five words were prepared. Each word began with a consonant and the words in each list were ordered so that, with the insertion of appropriate vowels the first letters of the words formed meaningful words. Three of the words formed were abstract (values of less than 3·65 on the Paivio *et al.* (1968) Concreteness scale) and three were concrete (values of more than 6·72 on the Concreteness scale). As far as possible Meaningfulness and Frequency were also controlled for the mnemonic words. All had Meaningfulness scores of over 4·68 and Frequencies of over 20 per million in the Paivio *et al.* norms. The words composing the lists were also controlled as much as possible for Imagery, Concreteness, Meaningfulness and Frequency. All five words in each list had Imagery values between 6·17 and 6·77, Concreteness values between 6·21 and 7·70, meaningfulness values between 5·84 and 7·04. The first four words in each list had Frequencies of 20 + per million and the last word had a Frequency of 8 or less per million. An example of one list of words was HAMMER, SLIPPER, PEACH, TRUCK, LEOPARD. The mnemonic word being HOSPITAL.

Each list was typed on a separate card. For the experimenter-generated mnemonic group, the appropriate mnemonic word was typed to the right of the list.

Response sheets were provided, with dotted lines for the responses, under the headings " List 1 ", " List 2 " etc. On the other side of the sheet six lines were given for subjects in the mnemonic conditions to record the mnemonic words that they had used.

Procedure

Ten subjects were randomly assigned to each of the three experimental conditions: Experimenter-generated mnemonics (E group); Subject-generated mnemonics (S group) and Control (C group).

Subjects in the C group were told to learn the list by serial repetition of the items. The subjects in the E group were told how the mnemonic word provided had been constructed and were instructed to use the word to help them remember the list. Subjects in the S group were asked to make up mnemonic words from the first letters of the words in the list and to use these words to help their learning.

Subjects were allowed 20 seconds to study the list on each card. The lists were ordered so that concrete and abstract mnemonic words alternated half the subjects in each group beginning with a list with a concrete mnemonic, half with an abstract mnemonic. After they had studied each list they were given the response sheets and asked to write down the words in their correct serial position. After three minutes the mnemonic group subjects were asked to turn over the sheets and write down as many of the mnemonic words as they could remember.

RESULTS

The number of words correctly recalled in all six lists was calculated (*a*) for those recalled in their correct positions, and (*b*) for recall in any order. One subject in the S group did not follow the instructions and his recall was not analysed. Two analysis of variance were performed, one for recall in correct order, one for recall in any order. In both cases, the factors were Groups (3) and Concreteness of mnemonic (2).

The mean recall for the three groups is shown in Table 1.

TABLE 1

MEANS AND STANDARD DEVIATIONS (SD) FOR ITEMS RECALLED IN CORRECT SERIAL POSITIONS AND IN ANY POSITION IN EXPERIMENT I

Group	Correct Serial Position		Any Position	
	Mean	SD	Mean	SD
Experimenter-generated mnemonics	6·4	3·9	7·5	3·9
Subject-generated mnemonics	4·1	2·5	6·2	2·7
Control	7·3	3·1	9·4	3·3

For recall either in the correct order, or in any order, there was no better performance by the E and S groups than by the C group. In fact, the means suggest better performance by the C group. However, the differences are not significant. For recall in correct positions $F=2{\cdot}45$; $df=2,26$, $P>0{\cdot}05$. For recall in any order $F=2{\cdot}37$, $df=2,26$; $P>0{\cdot}05$. If the concrete-abstract difference in the mnemonics had an effect, then an interaction between groups and concreteness should have occurred, with the influence of the mnemonics occurring for the E group, and, perhaps the S group, who tended to generate mnemonics similar to those given to the E group. However, in neither analysis did either the main effect of concreteness or the interaction with groups approach significance. For recall in any order, Concreteness;

F = 0·95; df = 1,26, Groups × Concreteness; F = 0·44, df = 2,26. For recall in correct order, Concreteness; F = 1·76, df = 1,26; Groups × Concreteness F = 0·95, df = 2,26.

The average number of mnemonic words recalled by the E group was 4. The average for the S groups was 1·6.

DISCUSSION

The first letter mnemonic failed to improve recall, either when provided by the experimenter or when generated by the subject. The small number of mnemonic words recalled by the subjects who generated their own mnemonics suggests that the time allowed for mnemonic invention was too short for mnemonic words to be found, although the other alternatives, that the mnemonics were more easily forgotten, or that the subjects did not always try to generate a mnemonic, cannot be rejected. Whatever the reason, it is clear from the results that the strategy of generating first letter mnemonic words is not an effective one even when the lists involved are short and there are 20 seconds allowed to learn each set of five words.

Since the mnemonic technique failed to aid recall it is not surprising that the concreteness of the mnemonic word had no influence on retention.

Two-thirds of the mnemonic words were remembered by the group using experimenter generated mnemonic words. It is not, therefore, possible to explain the failure of the mnemonic as the result of subjects either failing to retain or learn the mnemonic word. Rather, it appears that the mnemonics were frequently remembered, but failed to aid recall. Taken with previous studies which have usually found no improvement in recall when first letter mnemonics are employed it seems necessary to conclude that the first letter mnemonic technique is of little or no value in the learning of new serial lists.

The paradox of the popularity of the mnemonic technique remains. Surely so many people cannot be wrong? A possible explanation is that the studies, including Experiment I above, have involved the learning of lists of words which are new and unrelated. However, the mnemonic is usually employed in everyday life to retain the order of some known set of items. It may be that when learning a list of new words the first letter of the words is rarely a sufficient retrieval cue. However, when the set of items is known and the problem is one of remembering the correct order of the items, then the first letter mnemonic may be beneficial. The problem of remembering the colours of the rainbow or the shades of blue of the Oxbridge Universities is more one of remembering an apparently arbitrary order than one of retrieving the items involved. Gruneberg (personal communication) has found better recall by subjects using a first letter mnemonic to remember categorised items. The first letters may have been helpful cues in this situation where the pool of items is limited. The interpretation of the experiment must be approached with caution since the mnemonic groups were allowed longer for learning.

The hypothesis that the first letter mnemonic would prove effective if the set of items to be retained could be easily retrieved but the ordering was arbitrary, was tested in the second experiment.

EXPERIMENT II

Lists in which the items were known, but the ordering was random, and therefore difficult to retain, were formed by randomly ordering the days of the week. Subjects learned three such random orders.

METHOD

Subjects

Thirty-six undergraduates at Lancaster University acted as subjects during a lecture period.

Materials

Three random orders of the days of the week were composed. For each, a mnemonic phrase was devised, in which the first letter of the days of the week were ordered as the days in the list, and additional letters were inserted to make the phrases meaningful. Each list of the days of the week was printed on a separate sheet. For the mnemonic group, the mnemonic phrase was printed above each list with the letters representing the days in upper case, the other letters in lower case. The three mnemonics were SMiTe ThiS WiFe, FeaST WaS MeaT and TWiST FiLMS. The lists were made up into booklets with randomly ordered pages and a first page of instructions which described the task. No specific instructions on the technique for learning the lists was given to the control subjects. The mnemonic group had additional instructions asking them to use the mnemonic phrases to help their retention of the order of the days.

Response sheets were prepared, with the first day of each list printed at the top, and beneath each, dotted lines for the subjects to write their responses.

Procedure

Nineteen subjects received the mnemonics list and 17 the control lists. One minute was allowed for the studying of each list, after which the booklets were collected. Following an interval of about two minutes the subjects were asked to write out the three lists on the response sheets. They were told that only those days written in their correct serial position would be scored as correct. Where the subjects could not remember a word they were to guess, so that every line of the response sheets should be filled. On completing their recall, subjects in the mnemonic group were asked to write the mnemonics below the appropriate lists. The response sheets were then collected. After a 30-minute interval filled by a lecture, the subjects again attempted recall, following the same procedure as the first test.

RESULTS

Two of the subjects in the mnemonic group were rejected. One failed to write a word on each line of the response sheet. The second ignored the given first word from each list, and while reproducing the mnemonics correctly, produced responses which matched the mnemonic but which were written in incorrect positions.

The recall of the remaining subjects (17 in each condition) was scored for recall of a word in its appropriate serial position. The scores for the three lists were summed for each subject, giving a maximum possible score of 18. Table 2 reports the mean recall for the two groups in the two trials.

TABLE 2

MEANS AND STANDARD DEVIATIONS (SD) FOR THE ITEMS CORRECTLY RECALLED IN EXPERIMENT II AFTER 2 MINUTES DELAY (TEST 1) AND 30 MINUTES DELAY (TEST 2)

Group		Test 1	Test 2
Mnemonic	Mean	14·5	14·8
	(SD)	(3·3)	(3·1)
Control	Mean	9·7	9·4
	(SD)	(3·8)	(4·6)

An analysis of variance, with Groups (2) and Trials (2) as factors was performed. There was a significant difference between the mnemonic and control groups ($F=24{\cdot}30$; $df=1,32$; $P<0{\cdot}01$) but no effect of trials, nor a groups by trials interaction ($F<1$).

The proportion of mnemonics correctly reported on the first and second trials were 0·80 and 0·84 respectively. Where the mnemonic was correctly recalled, the proportions of items in their correct serial positions were 0·89 on both the first and second trials. Where at least a part of the mnemonic was incorrectly recalled, the proportions of items correct were 0·43 and 0·44. Where the mnemonic was correctly recalled, 92 per cent of the errors on both the first and the second trials occurred through reversals, where Tuesday was recalled for Thursday, Saturday for Sunday or vice-versa.

DISCUSSION

The provision of the first letter mnemonics led to far better performance on a task where the set of responses was known, but their ordering had to be remembered. This supports the hypothesis that the mnemonic aids the retention of order, but only when the items involved do not themselves have to be learned. It seems that the failure in many studies to find evidence for the effectiveness of the first letter mnemonic resulted from those studies requiring the learning of new sets of items. In such circumstances the first letter mnemonic seems to have been an inadequate cue to retrieval.

The effectiveness of the mnemonic is demonstrated by the overall performance of the two groups, but further support is provided within the mnemonic group, where recall was far more accurate when the mnemonic was correctly remembered.

The overwhelming predominance of reversal as the type of error when the mnemonic was correctly recalled indicates one weakness of this memory technique. Where two or more items share the same first letter, the mnemonic does not discriminate between them, and the subject may easily report the items in the wrong order. In the present experiment, just over 75 per cent of items that could be confused were recalled in their correct order. Pure guessing would be expected to produce 50 per cent correct, so that the subjects remembered more than would be expected if they had retained just the mnemonic, without some further knowledge of the order of the difficult items. A reduction in the reversal errors could probably be brought about by emphasising to subjects the need to independently remember the order of potentially confusable items. Extra cues might be incorporated into the mnemonic words, with extra letters indicating which item was which. However, this would increase both the difficulty of composing the mnemonic, and the length of the mnemonic to be remembered.

The failure to find a decline in recall between trials requires comment. Probably, the advantages to learning produced by the initial recall test outweighed the loss with time between tests.

The conclusion that can be drawn from the two experiments reported here is that the first letter mnemonic technique is unsuitable for the learning of new sets of unrelated items. However, the confidence of the general public in the utility of the technique is supported when the set of items is already well known, but the problem is the retention of an arbitrary order. Experiment II used days of the week as the items to be remembered. However, there is no obvious reason for believing that the ordering of any other set of items that is either already known to the learner, or which may be quickly acquired or generated will not be better retained through the use of the mnemonic. The teacher and the student will find appropriate applications when the need to learn combines with the unconnectedness of the material to be acquired.

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CHILDREN'S CONCEPTS OF PROPORTION: AN INVESTIGATION INTO THE CLAIMS OF BRYANT AND PIAGET

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SUMMARY. An investigation of the different claims made by Bryant and Piaget about children's ability to make proportional judgments is presented. Using a sample of 59 children aged between 5 and 11 years, it was found that contrary to Piaget's predictions they could logically connect two discrete perceptual experiences as demanded by proportional type tasks. As suggested by Bryant's thesis, the difficulty young children found in making proportional judgments was one of analysing these initial perceptual relationships. Minor modifications to Bryant's thesis are proposed, which entail extending it to include relative x absolute coding as a higher level cognitive skill. This enables discrete levels of understanding the concept of proportion to be identified. From a theoretical viewpoint this study adds support to Bryant's critique of Piaget's work.

INTRODUCTION

Recent work by Bryant (1974) has suggested that there are severe limitations in Piaget's analysis of the development of cognitive skills in pre-adolescent children. Bryant and Trabasso (1971) have shown that young children (4- and 5-year-olds) are able to make transitive inferences (given $A = B$ and $B = C$, they can deduce that $A = C$), though they may not be very good at creating the initial situations from which these inferences can be made. They do not, as Piaget suggests (1969), need a grasp of the logical principles involved in the initial situation, before being able to learn from discrete perceptual experiences.

These two contradictory propositions are well illustrated by considering children's understanding of the concept of proportion. To make a proportional judgment two ratios have to be recognised as being equal or as being in the same equivalence class (see Skemp, 1971). That is, given two ratios 2 : 4 and 3 : 6 the identity element of 1 : 2 has to be extracted.

Piaget takes the concept of proportion as an illustration of the kind of problem that cannot be solved until the adolescent stage of formal operations. Proportional judgments are seen as requiring the recognition of ' relationships of relationships ' (Piaget and Inhelder, 1975, p. 160) and have been incorporated into tasks to demonstrate the pre-adolescent's inability to apply operations to operations (Inhelder and Piaget, 1958). Thus the younger child's problem in making proportional judgments is seen as one of connecting two discrete ratios into an overall equivalence class. Given two ratios, it is suggested that the young child lacks the necessary cognitive skills to link them together by constructing a common identity element.

Bryant's thesis starts with the basic premise " that young children can on the whole register and remember relative values with great ease but have problems in situations in which they must remember absolute values along any continuum " (Bryant, 1974, p. 14). Thus the development of cognitive skills is seen as progressing from the initial ability to make relative judgments, to being able to quantify these in absolute terms. Studies undertaken by Bryant (1974) and by Lawrenson (1974) have demonstrated that young children can make proportional type inferences, and that consequently they can utilise an overall operation to link two discrete perceptual experiences. If young children experience any difficulty in making proportional judgments, it is not seen as a result of any inability to make an overall inference, but as a failure to make the correct initial analysis. The more complex this initial analysis, that is the more it depends on absolute rather than relative coding, the more difficult the proportional judgment will be.

Although Bryant and Lawrenson appear to have shown that young children can make proportional type inferences, careful examination of their experimental work suggests that alternative interpretations are possible. The task set the children was to match a given ratio, the standard, with one from a series of choices (Figure 1). There were six different conditions as illustrated, but it can be argued that four of these are open to interpretations other than those put forward by Bryant. In the three conditions in which the ratios are emphasised by sectioning, the children are able to match the standard by utilising simple one to one correspondence cues. The condition in which the correct answer is exactly the same size and shape as the standard is similar. None of these conditions requires proportional inferences in order to match the standard correctly. Bryant has suggested that the use of one to one correspondence cues is characteristic of relative coding, yet proportional judgments require that relative judgments be quantified multiplicatively. Rather than simply perceiving that there is more red than green, the absolute nature of this relationship must be stated, for example that there is twice as much red as green.

The only conditions which enable this kind of judgment are the non-sectioned ratios where the size of the standard differs from that of the choices. A re-analysis of these data from Lawrenson's work using the binomial test (Guilford and Fruchter, 1973), found that the trend towards making proportional judgments was not significant. Thus, although the children were able to make inferences these were based on simple relative cues rather than on proportional coding. To investigate children's understanding of proportion a task must be presented which controls for simple one to one matching and which can *only* be solved by proportional reasoning. Given such a task, on the basis of Piaget's theory it would be predicted that young children would be unable to make proportional inferences, whereas Bryant's thesis would suggest the converse. An investigation of the above predictions was undertaken which also examined Bryant's claims that young children utilise relative coding prior to absolute coding.

METHOD

An entirely different procedure from that of either Piaget or Bryant was adopted. The task was divided into two parts. Initially the child was shown pictures which were described as a ' stick of rock ' and two ' trays of sugar ' (Figure 2). The child was told that the man who owned the rock-making factory was going to make a much bigger stick of rock using exactly the same colours in exactly the same pattern, and was asked to choose which tray of sugar the man would use. This assessed whether the child was capable of making relative more or less judgments, that is whether the child was able to select the tray of sugar in Figure 2 with more striped than plain sugar.

The second part of the task was to present the child with three more ' sticks of rock ' (Figure 3) and ask which one was made by the man, reminding the child that it had exactly the same colours in exactly the same pattern. To select the correct ratio choice and make a proportional type judgment, the child must code the relationship between the striped and plain ' sugar ' on the smaller ' stick of rock ' proportionally, and use this analysis as the basis on which to make a choice. If the child's initial analysis is based on the simple relative inference that there is more striped than plain rock, there is no basis on which to choose between the ratio and the relative choices. On the other hand, if the child analyses the initial relationship on the basis of matching one to one size cues, he might select either the relative choice, on the grounds that

FIGURE 1

Conditions for Ratio 1 : 3 (Bryant, P., 1974; Lawrenson, W., 1974)

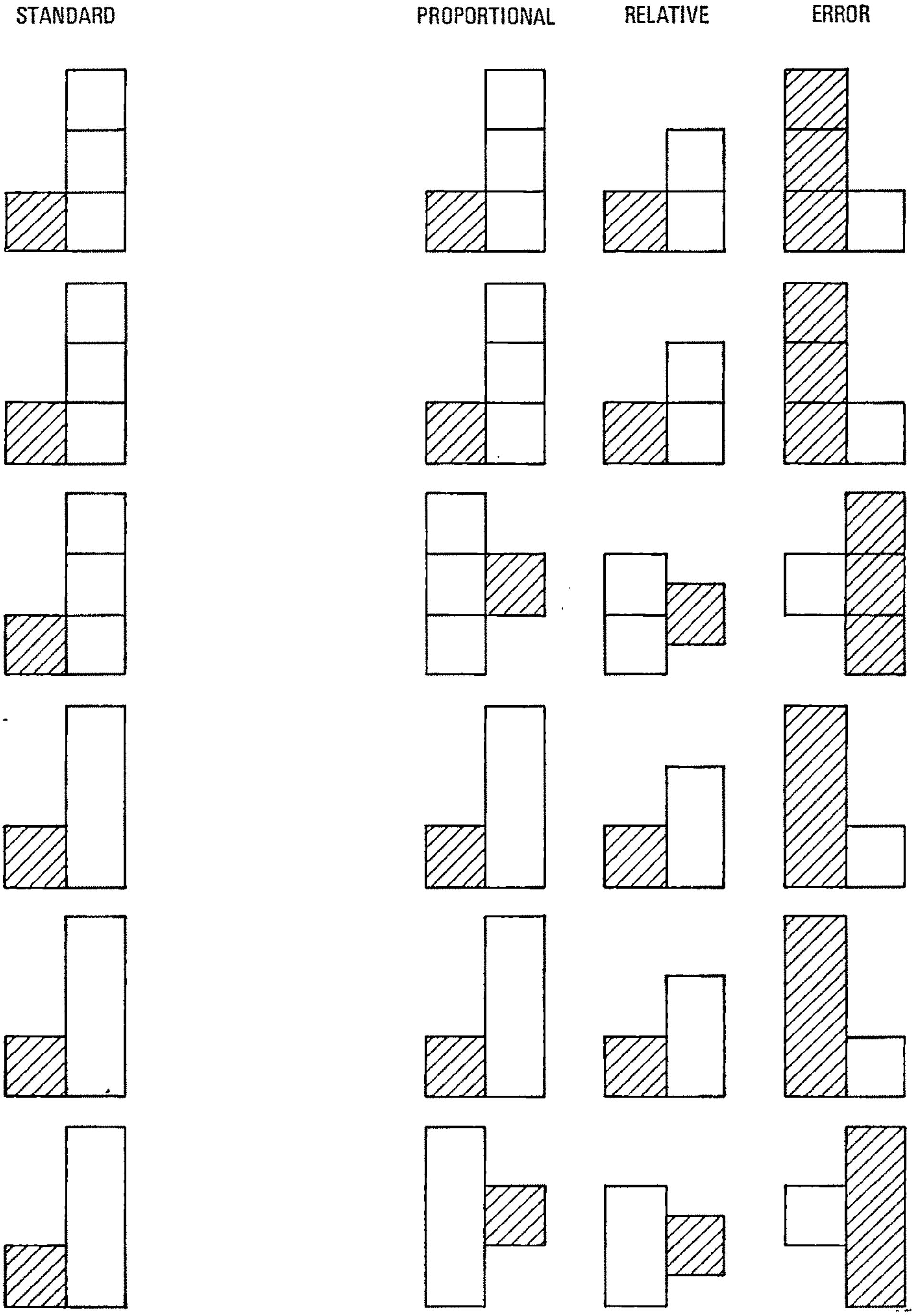


FIGURE 2

THE 'STICK OF ROCK' AND 'TWO TRAYS OF SUGAR'

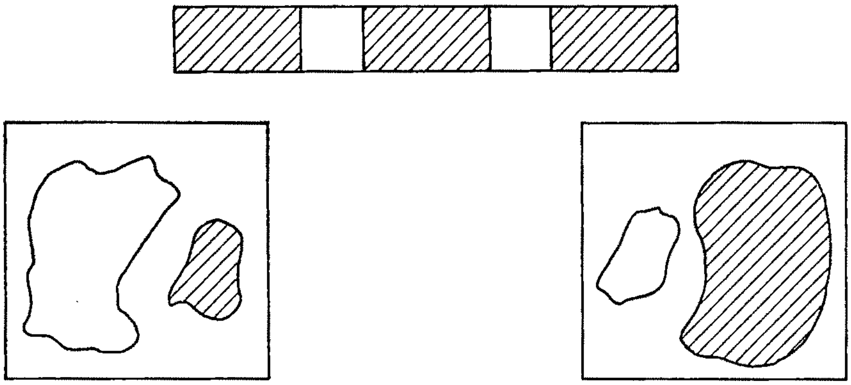
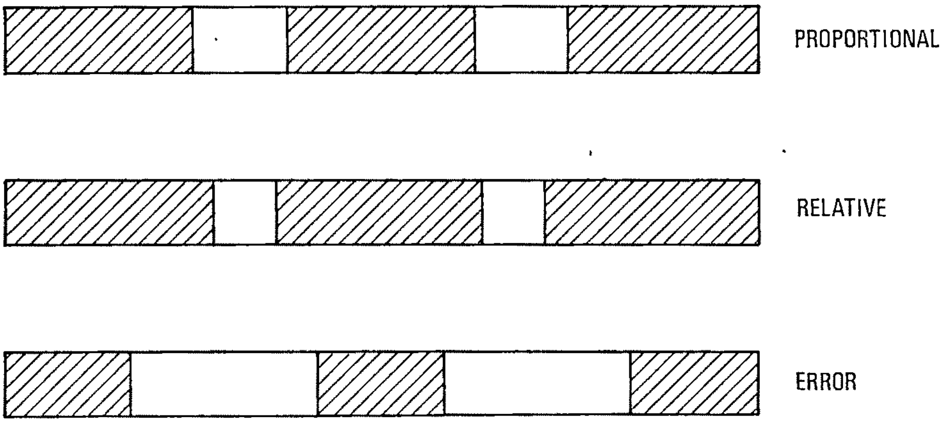


FIGURE 3

THE THREE CHOICES



it has the same amount of plain 'sugar', or the error choice, on the grounds that there is the same amount of striped 'sugar'. Thus the only way the child could select the correct ratio choice is by making a proportional judgment. To control for the possibility of the child forgetting the original stick of rock, Figures 2 and 3 were presented simultaneously.

Fifty-nine children of both sexes from a local primary school made up the sample. There were twelve 5-year-olds (Mean = 5 : 6, range 4 : 10 to 5 : 9); fourteen 7-year-olds (Mean = 7 : 2, range 6 : 8 to 7 : 9); seventeen 9-year-olds (Mean = 9 : 0, range

8 : 7 to 9 : 4); and sixteen 11-year-olds (Mean = 11 : 3, range 10 : 7 to 11 : 6). After one trial using a ratio of 1 : 3 to demonstrate the procedure but not how to do the task, the three ratios 1 : 11, 1 : 5, and 1 : 2 were presented in random order.

RESULTS

The results are presented in Table 1 and were analysed using non-parametric procedures. Within-age differences were compared using the binomial distribution (Guilford and Fruchter, 1973), and age differences were compared using a test for the significance of the difference between two observed proportions (Brown, 1956). It was found that all but the 5-year-olds significantly selected the tray which contained the correct relationship of striped to 'plain sugar' (P = < ·01 for ages 7-, 9-, and 11-year-olds). Thus all but the 5-year-olds consistently used relative coding, though the older children selected significantly more correct relative choices than the two younger groups (11- *vs.* 7-year-olds P = < ·01, 11- *vs.* 5-year-olds P = < ·01, 9- *vs.* 7-year-olds P = < ·01, and for 9- *vs.* 5-year-olds P = < ·01). In the second part of the experiment it was found that the oldest children selected significantly more proportional choices (11- *vs.* 9-year-olds P = < ·01, 11- *vs.* 7-year-olds P = < ·01, and for 11- *vs.* 5-year-olds P = < ·01), and when proportional and relative choices were combined and each age range compared, an age related trend was evident though the 9-year-olds performed no better than the younger children (11- *vs.* 9-year-olds P = < ·05, 11- *vs.* 5-year-olds P = < ·01, and for 7- *vs.* 5-year-olds P = < ·01).

TABLE 1

Choices Grouped by Type and Age Range

Age-Group		Part 1		Part 2		
		Correct	Incorrect	Proportional	Relative	Error
Mean 5 : 6	12	22	14	6	16	14
Mean 7 : 2	14	31	11	9	26	7
Mean 9 : 0	17	48	3	15	22	14
Mean 11 : 3	16	43	5	27	16	5

Ongoing work on children's ability to quantify continuous and discrete proportions (Muller, 1977) has suggested that three levels in understanding the concept of proportion can be identified which parallel the framework postulated by Bryant. At Level 1 very young children appear unable to make consistent relative choices. By Level 2 this ability to maintain the correct more or less relationship has been acquired, but it is only when these judgments can be quantified multiplicatively at Level 3 that proportional inferences can be made. A similar breakdown was made for each age range with the present data. The criterion for Level 3 was three correct choices in Part 1 and at least two proportional and no error choices in Part 2; for Level 2 it was three correct choices in Part 1 and at least three relative choices in Part 2. All the others were put at Level 1. The criteria were demanding to ensure that children classified at Levels 2 and 3 were genuinely capable of the form of reasoning characteristic of that Level. Using all four age ranges it was found that the older children had a more sophisticated understanding of the concept of proportion (x^2 = 27·02, df = 6, P = < ·001). However, the expected cell frequencies were too small to use this other than as a guide but when the results of the two younger and the two older age ranges were combined (Table 2), it was confirmed that the older children used significantly more proportional coding than the younger group (x^2 = 15·87, df = 2, P = < ·001).

TABLE 2

Distribution of Children by Age and Level

	Mean Age 6 : 4	Mean Age 9 : 11	Totals
Level 1	15 (9·25)	6 (11·75)	21
Level 2	11 (11·46)	15 (14·54)	26
Level 3	0 (5·29)	12 (6·71)	12
Totals	26	33	59

Note—Bracketed figures are expected frequency distributions.

DISCUSSION

Contrary to Piaget's predictions it is clear that young children can logically connect two discrete perceptual experiences by constructing a common identity element, be it size, colour, or proportion. The problem for the young child is, as Bryant suggests, that of making the correct initial analysis, in this case choosing between size, colour, and proportion and deducing that proportion is the only consistent cue. Young children do seem to have difficulty in making proportional judgments, but not for the reasons put forward by Piaget. Furthermore, it has been demonstrated that young children tend to utilise relative coding prior to absolute coding as suggested by Bryant. These findings support Bryant's criticisms of Piaget's analysis of the development of cognitive skills in pre-adolescent children.

However, it appears necessary to make minor modifications to Bryant's own interpretation of the development of the concept of proportion in young children. The results above suggest that very young children tend not to make initial analyses based on proportion, but on simple one to one relative cues. In addition, older children making proportional inferences cannot use an absolute code in isolation, but have to use a combination of relative × absolute coding. This possibility was intimated by Bryant (1974, p. 100) but was not followed up empirically. The above analyses support an extension of his thesis to include relative × absolute coding as a higher level cognitive skill to account for the development of understanding the concept of proportion.

In summary, it is suggested that Bryant's thesis provides a more appropriate framework for analysing children's understanding of the concept of proportion than Piaget's work. Young children initially have to learn to make inferences on the basis of relative cues, which have to become quantified in absolute terms, before multiplicative relative × absolute inferences can be made. It is at this level that children are able to make proportional judgments.

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GENERALISING THROUGH THE VERBAL MEDIUM

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SUMMARY. When presented with abstract notions through the verbal media of books, newspapers, talks, TV and radio, people often produce quite erroneous generalisations. Thus the notion *aggression* can evoke, besides a true generalisation *inhumanity*, a particularisation *imperialism*, a transductive *exploitation*, and an associated but non-essential attribute *detestable*, each of the last three being mistaken as a notion more general than the original concept. These aberrations may be more marked, the more persuasive the medium and the more emotionally involved the listener or recorder.

This paper describes a method of investigating such possible trends among young people and adults and reveals their extent in samples of graduates, undergraduates, further education students and secondary pupils. A test of generalising, embodying the alternatives set out above, revealed that whilst 90 per cent of students in all groups correctly responded to the concrete items, their responses to the abstract items ranged from some 80-60 per cent. The implications of these findings are discussed against the possible intellectual confusion arising in less sophisticated adults when they encounter ideas in verbal experience and discourse.

THE PROBLEM

LITERATE adults achieve their ' generalisations ' by means of language in a variety of ways, not all of which would satisfy the ontologist. This variety is due to our heavy dependence upon the written and spoken word and is more marked, the more abstract the ideas involved in text and discourse. The range of ' generalisations ' is also widened by our exposure to the persuasive media—newspapers, books, television and radio. Generalisations having strong emotional concomitants, as in attitudes, beliefs and sentiments, are particularly sensitive to these influences. Consider for example some ' generalities ' which could emerge from the set of notions:

aggression, unilateralism, exploitation, genocide.

First, we could subsume them under the more general notion of *inhumanity*, basing our generalisations on a common thread of abuse of mankind, which is implicit in each of the four terms. Such a generalisation would be acceptable ontologically and would satisfy most of us as being free from prejudice. There might be, however, some people who would not include all four categories in the idea of inhumanity.

Next, one might find people equating the totality of the set of four notions with one of such general alternatives as *deprivation* or *suppression*. These terms are really at the same level of generality as the original concepts and are partial—each is not associated with all four concepts. This extension is somewhat akin to a tendency in children's thinking, identified as transduction, where the basis of grouping material phenomena, shapes and objects, is shifted as more instances are considered and where ' generalising ' is derived from only part of the total array of instances. As an adult phenomenon, in relation to textual material, it is influenced by the wide coverage of the notions involved and by personal commitment, giving rise to partial selection in the thought processes.

Thirdly, finding only partial support, depending on political allegiance and emotional involvement, there could be such alternative ' generalisations ' as:

imperialism, fascism or *communism.*

As ' generalisations ', these responses would be quite unacceptable ontologically, but they are none the less very prevalent and must be considered seriously by the psychologist. Political, social or cultural commitment is widespread and important in its results, since it may relate the four constituent subnotions to a more particular idea or value. Many people slip easily into such identifications and the use of them is a standard ploy of those who wish to influence public opinion and action. When viewed as a psycholinguistic phenomenon, this type of ' generalisation ' is seen in fact to be a piece of particularisation! For example, fascism is more specific than any of the original four terms, each of which could be regarded as an attribute of it.

Lastly, a reaction common to the four terms might be *distaste* or *abhorrence.* These express non-essential attributes of the original notions, and reflect personal values.

We shall utilise the cognitive processes involved in these four kinds of responses in test material designed to evoke different ' generalising ' tendencies in adolescents and adults. The test material will encompass much more than political assertions, *for the tendencies may enter into all areas of knowledge at higher levels served by sophisticated and abstract language and linked with value structures.*

THE RESEARCH BACKGROUND

The influence of commitment and prejudice upon cognition in attitudes, beliefs and sentiments has been extensively investigated and discussed in the psychology of attitudes (Lemon, 1973), but the present research is not concerned with these issues. However, studies of the psycholinguistic tendencies in adolescent and adult thought, affecting and affected by socio-emotional aberration, have rarely been looked at extensively or in depth. But Abelson and Kanouse (1966) have examined the influence of more specific and definite sentences upon the readiness to accept sweeping generalisations such as: *Imperialists use inhuman weapons.* These investigators varied the specificity of the subject and object of their sentences as well as the nature of the verb, manifest (action) or subjective (mental process) and also the effect of implanting the generic assertion inductively or deductively. Their findings are of interest practically as well as theoretically. Specific objects are more effective than specific subjects, manifest verbs more influential than subjective verbs, and inductive implanting through low-level concrete evidence more powerful than deductive implanting by high-level abstract evidence. A final point to note is that little of the research upon the influence of the media upon their viewers and audiences has been concerned with the effects on cognition and concept formation.

In the present research it is proposed to use material involving general concepts and their subset, subsuming notions, presented in the form of their names. The work can thus be related to investigations in cognitive psychology on the emergence of conceptual thinking. It is hoped to demonstrate that the use of word-symbols, so characteristic of adolescent and adult thought, for actual conceptual entities, will reveal tendencies unique to the thinking of older people and not evident in concept formation from classes of tangible shapes, objects, and pictures (Piaget and Inhelder, 1964; Goldstein and Scheerer, 1941; Annett, 1959), where word notions are only ancillary to the perceptual setting of the problem situation. In its concentration upon the verbal presentation of concepts the research will have some affinity with a few earlier researchers (Werner and Kaplan, 1952; Bruner *et al.*, 1966; de Silva, 1972) and, as we shall see, the study is related to the research of Abelson and Kanouse (1966).

THE OBJECTIVES

The basic objectives of this study are to test the extent that ontologically unacceptable generalisations arise from three failures.

(1) To distinguish when a term is an attribute of a notion and when it is subsumed in a higher level generalisation. For example, in the set of words already discussed, *aggression, unilateralism, exploitation, genocide,* each (in adjective form) could be

an attribute of the more specific notion of *fascism*, or subsumed under the more general notion of *inhumanity*.

(2) To distinguish between further generalisations or transductions of the same degree as those in the original set, and those of a genuinely higher degree of generality. Referring back to the original example, giving such a word as *deprivation* instead of *inhumanity*, would be an instance of such a transduction.

(3) To distinguish between essential and non-essential attributes. For instance, the four terms mentioned could give rise to the notion of *repulsion* or *detestation* in many people, but such an attribute as *detestable* or *expedient*, unlike the term *inhumane*, is not an essential part of the notions of *exploitation*, *aggression* and *genocide*. Non-essential attributes often reflect attitudes to the concepts involved.

It is assumed that the more abstract the psycholinguistic content, the greater the tendency to make these confusions. This tendency may also be augmented if the concepts used in the test material are those about which people are likely to have definite attitudes.

The final technique developed consisted of presenting 10 items with three notions in each item, for instance:
charity, sympathy, tolerance
beneath which four terms were placed from which the person tested had to select the one which best expressed for him the overall meaning of the first three notions. In the above instance, a list of four alternatives consisted of:
voluntary work, humanity, generosity, lacking in some people
embodying respectively: a more particular notion (designated as *P*) of which the three test terms were attributes; a more general (G) notion, *humanity*, which the three terms subsumed; a notion at the same level of generality, *generosity*, the choice of which would involve transductive (T) thinking; and a non-essential (N) attribute *lacking in some people*.

Each of the 10 items of the test had the above multiple-choice form. The technique goes beyond the usual multiple-choice technique, where one only response is considered correct and the rest of the information gathered from the unwanted responses is ignored. In this test each of the four elements of the multiple choice is scored.

PILOT VERSION

After preliminary trials, 10 items of a more concrete kind were added, such as:
chair, dressing table, stool
select from
well-made, Queen Anne, furniture, wardrobe (Key NPGT)
making up the full pilot version of the test. By this addition it was hoped to assess how far the purpose of the test was understood and the sense of overall meaning identified in the more general category embracing all the three test terms. Assuming this would occur, we could then validly explain the departures from such choices in the other 10 more abstract items in terms of the notions set out above. The results supported this assumption with 88 and 91 per cent in two separate samples (N=85 and 93) endorsing the 'generalising' response for concrete items, compared with 63 per cent for the abstract items (both samples).

MAIN INVESTIGATION

The pilot study suggested minor modifications to four items, leading to the final test (see Appendix) which was used to measure the overall pattern and change in GPNT responses across samples of young people and adults.

Samples

(1) 51 graduates and undergraduates, made up of 16 third-year undergraduate psychologists, 11 M.Ed. students and 24 B.Phil.(Ed.) students (referred to as the graduate sample for convenience).
(2) 113 first-year undergraduates taking Educational Studies.
(3) 84 further education students, from a college in Lancashire.

ANALYSIS OF THE RESULTS

The results were first analysed by calculating the means and standard deviations of the distribution of the responses of each of the three groups of the concrete and abstract items separately. The product-moment correlation coefficient was also calculated between the concrete and abstract scores for the members of the three groups. These statistics are given below in Table 1.

TABLE 1

MEAN SCORES AND STANDARD DEVIATIONS OF GENERALISING RESPONSES TO CONCRETE AND ABSTRACT ITEMS

Items	Graduates Mean (SD)	Undergrads. Mean (SD)	Further Educ. Mean (SD)
Concrete	9·61 (0·79)	8·90 (1·61)	9·12 (1·25)
Abstract	8·10 (1·06)	7·13 (1·84)	6·09 (1·87)
NCA	·221	·596	·207
(N)	(51)	(113)	(84)

On the basis of the above statistics, the standard errors of the difference between the various means were calculated, and the actual differences converted to multiples of their standard errors. The probability of such multiples occurring by chance were then entered from the normal probability table.

TABLE 2

COMPARISONS OF MEANS FOR PAIRS OF SAMPLES ON CONCRETE AND ABSTRACT ITEMS

Concrete Items	Diff. mean	SE diff.	$\frac{\text{Diff.}}{\text{SE}}$	P<
Graduate—Undergraduate	·705	·1881	3·748	·001
Graduate—F.E.	·490	·1758	2·787	·05
Undergraduate—F.E.	·115	·1090	1·055	·NS
Abstract Items				
Graduate—Undergraduate	·965	·2280	4·233	·001
Graduate—F.E.	2·006	·2526	7·941	·001
Undergraduate—F.E.	1·041	·2673	3·895	·001

It will be seen that the critical ratios are very significant, particularly in the case of the responses of the abstract items.

The significance of the difference between the mean responses to concrete and abstract items is least marked in the graduate sample and most marked in the sample of further education students.

TABLE 3

COMPARISON BETWEEN THE RESPONSES OF EACH GROUP TO THE CONCRETE AND ABSTRACT HALVES OF THE TEST

	Difference in means between C and A	Standard Error	Critical Ratio
Graduate	1·510	·1652	9·14
Undergraduate	1·770	·1470	12·04
Further Education	3·026	·2205	13·72

The results are now set out first by the percentage of G, P, N, T responses made by each group to the sets of concrete and abstract items separately.

TABLE 4

PERCENTAGE RESPONSES TO CONCRETE AND ABSTRACT ITEMS

Items	Response	Graduate (N=51)	Undergrads. (N=113)	Further Educ. (N=84)
Concrete	G	96·0	89·0	91·0
	P	2·8	6·7	3·9
	N	1·0	3·5	3·8
	T	0·2	0·4	1·1
No response		0·0	0·3	0·4
Abstract	G	82·0	71·3	58·6
	P	3·8	8·7	8·8
	N	6·5	11·1	12·0
	T	7·8	8·4	17·2
No response		0·0	0·5	3·4

As in the pilot study, generalising from the concrete items can be correctly achieved by most students. With abstract items, however, there is a *fall* in the percentage of correct G responses from graduates to undergraduates ending with the further education students.

There is a parallel *rise* in T (Transductive) responses. It is also interesting to note the greater preponderance of T and N responses over those of P. These differences will be examined more closely later, in relation to individual items, but we may note at this stage that even though the adult is less likely to particularise than the child, he is still susceptible to transductive and non-essential distractions. Finally Table 4 draws attention to the fact that, even with graduates, there is only an 82 per cent correct G response to the abstract items.

Turning now to the responses of each of the three groups of subjects to the 10 *individual* abstract items, Table 5 reports the percentage G, P, N and T responses of these groups to each of these items.

The location of low G and high PNT groups of percentages are then identified in Table 6 by the actual responses, where also for sake of clarity in discussion the percentages are entered as rounded whole numbers.

From the entries in this table, we may now examine those items which drew high rates of the erroneous P, N and T responses, in order to attempt some qualitative explanations in terms of the points made in the opening of this paper.

TABLE 5

PERCENTAGE RESPONSES TO ABSTRACT ITEMS

Response	Group	Item Number									
		5	7	9	10	11	14	15	16	17	19
G	Graduate	88·2	98·0	92·2	96·1	94·1	96·1	84·3	54·9	58·8	56·9
	Undergraduate	83·2	87·6	80·5	94·7	77·0	73·5	69·9	41·6	50·4	54·9
	Further Education	64·7	88·2	49·9	87·1	61·2	62·4	45·9	28·2	55·3	43·5
P	Graduate	0·0	0·0	2·0	0·0	2·0	0·0	5·9	21·6	2·0	3·9
	Undergraduate	0·9	2·7	8·9	0·0	0·9	8·9	18·6	40·7	2·7	2·7
	Further Education	2·4	5·9	12·9	1·2	0·0	14·1	16·5	28·2	3·5	3·5
N	Graduate	5·9	0·0	3·9	2·0	3·9	2·0	9·8	2·0	13·7	21·6
	Undergraduate	9·7	8·9	5·3	3·5	18·6	8·0	9·7	0·9	26·7	19·5
	Further Education	22·4	3·5	5·9	3·5	24·2	3·5	25·9	5·9	16·5	11·8
T	Graduate	5·9	2·0	2·0	2·0	0·0	2·0	0·0	21·6	25·5	17·6
	Undergraduate	5·3	0·9	5·3	1·8	2·7	8·0	0·9	16·8	20·4	22·1
	Further Education	8·2	2·4	28·2	8·2	10·6	17·7	8·2	33·0	17·7	37·6
No response	Graduate	—	—	—	—	—	—	—	—	—	—
	Undergraduate	0·9	—	—	—	0·9	1·8	0·9	—	—	0·9
	Further Education	2·4	—	3·5	—	7·1	2·4	3·5	4·7	7·1	3·5

TABLE 6

LOCATION OF LOW G AND HIGH PNT PERCENTAGES OF RESPONSE TO EACH ABSTRACT ITEM

Test Item	Low G response (65 %)			High PNT responses (>6%)								
				P			N			T		
	Grad.	U/G	F.E.	Grad.	U/G	F.E.	Grad.	U/G	F.E.	Grad.	U/G	F.E.
5	—	—	65	—	—	—	—	10	20	—	—	8
charity . . .	humanity						lacking in . . .			generosity		
7	—	—	—	—	9	13	—	9	—	—	—	—
defeat . . .				lost game			des. sympathy					
9	—	—	49	—	9	13	—	—	—	—	—	28
boom . . .	prosperity			comm. success						thriving life		
10	—	—	—	—	—	—	—	—	—	—	—	8
pastime . . .										excursion		
11	—	—	61	—	—	—	—	19	21	—	—	10
outcast . . .	non-conformist						unhappy			critic		
	—	—	62	—	9	14	—	8	—	—	—	—
murder . . .	inhumanity			fascism			detestable					
15	—	—	46	—	19	7	10	10	26	—	—	8
evolution. . . .	systematic change			emergence of new society			important in understanding			co-ordination		
16	55	42	28	22	41	28	—	—	—	22	17	33
stamina . . .	power			athletic drive						capacity		
17	—	50	55	—	—	—	14	27	17	26	20	18
disloyalty	disobedience						necessary in some cases			infringement		
19	57	55	44	—	—	—	22	20	12	18	22	38
inventory	list						necessary in organisation			card index		

Starting with the particularising (P) responses, we note that the following items produced the highest percentages:

defeat, vain attempt, flop	*lost game*
boom, affluence, well-being	*commercial success*
evolution, reorganisation, differentiation	*emergence of the new society*
murder, aggression, exploration	*fascism*
stamina, thrust, vigour	*athletic drive*

In these five responses we may see demonstrated the influence of interest attitude and values over the power of reason. For example the undergraduate and further education students, the young people often with strong feelings against dictatorship, made the highest number of ' fascism ' responses to the ' murder ' set. Similarly the current high interest in reorganising society appeared to sway the judgments of all groups except that of the graduates.

In the case of the last response on the above list, ' athletic drive ', to the set of ' stamina, thrust, vigour ', the proximity in meaning of the response and the set of stimulus words may also just make the item harder. However, the ' subject predicate ' test, in which the predicate is the more general notion, clearly indicates that ' athletic drive ' is more particular than any one of the set of stimulus words: *athletic drive invokes stamina etc.* but *stamina is athletic drive,* has as little meaning as *a flower is a rose.*

The incidence of non-essential (N) choices is very marked among the responses to the abstract items. Thus we have the sets:

charity, sympathy, tolerance	*lacking in some people*
defeat, vain attempt, flop	*deserving sympathy*
outcast, rebel, solitary	*unhappy*
evolution, reorganisation, differentiation	*important in understanding life*
disloyalty, passive resistance, desertion	*necessary in some instances*
inventory, file, record	*necessary in a large organisation*

When considered together, these responses are seen to express particular characteristics, beliefs, opinions or evaluations, which are in no way essential to the sets of ideas which form the stimulus items. That this is so, may be brought out by putting the test words and the responses in sentence form, as follows:

sympathy is lacking in some people;
a vain attempt is deserving of sympathy;
a solitary is unhappy;
passive resistance is necessary in some instances.

We may perceive how remote these assertions are from true generalisations. They are in fact created characterisations and, as such, fall within the class of synthetic statements, whose predicates are not subsumed in their subjects: e.g. The plane is late or The boy is lazy.

Transductive responses revealed themselves most frequently in the following cases:

boom, affluence, well-being	*thriving life*
outcast, rebel, solitary	*critic*
stamina, thrust, vigour	*capacity*
murder, aggression, exploitation	*suppression*
disloyalty, passive resistance, desertion	*infringement*
inventory, file, record	*card index*

This class of deviance from true generalising may be least easy to pin down when the stimulus terms are themselves of a high degree of generalisation. Finer semantic distinctions may be involved when the difference between a true generalisation and a transduction is not large, as in the following instances:

stamina, thrust, vigour	*capacity*
murder, aggression, exploitation	*suppression*

However, the alternative generalising responses to these items of *power* and *inhumanity* respectively, seem to fulfil the requirements for true generalisations set out earlier, which the terms *capacity* and *suppression* do not do so well. All the above transductive responses exemplify the subtler aberrations which often blunt and mar communication and discourse in terms of higher level notions and concepts.

DISCUSSION

The investigation arose out of two observations, one recurrent and longstanding, the other more particular. First, it may be noted often, that when the media present topical material, inevitably in the terms of general notions such as democracy, liberty, suppression and unilateral action, these frequently become identified with phenomena arousing passions in the viewer or hearer. The same is true of newspaper reading. As a result, partial misjudgments may arise by which the thinker is convinced he is categorising the presented material under more general and comprehensive headings, whereas in fact he is often merely particularising, transducing or grouping in terms of some non-essential attribute, such as *desirable, deplorable* or *likely* etc., which is none the less important to him.

There are two forces at work here: first, the selective attentions of a viewer committed to an attitude who is also limited in the amount of information he can sift and evaluate at any particular time and, second, the restriction introduced into the thinking situation by over-simplification by the media in their presentation of the topic. The latter has been discussed by media experts (Birt, 1975; Day, 1975), but the former, a psychological phenomenon, has received little attention. In passing, one may put in a plea that this deficiency warrants the inclusion of a cognition or developmental psychologist as a member of any group considering the effectiveness of the media.

Similar misjudgments may also arise in the progress of normal discourse, if its content involves abstract and general notions, likely to promote debate. Something seems to exist which we may label, from our state of after-knowledge, as a GPNT problem in the operation of thought, that may also bear on the effectiveness of the comprehension of textual material.

The more particular incident arose at an educational meeting concerned with concept formation. At one point a participant suggested that the idea of *comprehensive schooling* was a superordinate concept encompassing the notions of *equality of opportunity, educational sensitivity* and *balance of studies.*

The connection between the four ideas is pertinent, but he was making the particularising aberration, when he should have come up with something like *educational objective* as a true generalisation from the three notions. The point is not as trivial as it may appear, for such confusion contributes something to the more partial and fruitless debate on educational topics.

The study itself was designed to investigate such deficiences in thinking in a more controlled way. We can now consider whether the test devised to measure the four alternatives GPNT responses achieves its purpose. We have to consider the two familiar problems of item construction and validity of the test as a whole, with a novel element introduced in the positive use of all the alternatives in the multiple choice.

Taking first the problem of item construction, we note that the generalisation (G) and particularisation (P) responses are largely capable of being selected objectively by logical methods, using the sentence method in which the test and response terms are put in the subject and predicate positions, and vice versa in sentences of this form:

$$\begin{bmatrix}\text{Test} \\ \textit{or} \\ \text{Response term}\end{bmatrix} \quad \text{is} \quad \begin{bmatrix}\text{Response} \\ \textit{or} \\ \text{Test term}\end{bmatrix}$$

In carrying out this technique we are in fact utilising the structure of the analytic statement. Where the subject is of a high degree of generality, it may be necessary to obtain a consensus of opinion as to the correct more general response (G). The non-essential attribute response (N) was also easy to identify by using the test of a synthetic statement where the predicate is *not* implied in the subject. Identification of a transductive response (T) of the same degree of generalisation as the test terms is somewhat more difficult with the abstract items. We require partial overlap without increased generality. The sentence criterion ensures that the latter condition is met. The question of overlap is semantic and a consensus of opinion was obtained in certain cases.

As to test validity, it is difficult at this stage to devise an external criterion. We need first to build up some correlational information giving a comparison between performance on a test and on cognate test material. This procedure has been started (Powdrill, 1977), giving a correlation coefficient of ·34 with the AH4 intelligence test and ·38 with a measure of the children's abstractness of writing. More information will be coming in from current pieces of research.

Internally, however, close attention was given to construct validity. The use also of a mixture of concrete with the more abstract items of the real test, in order to ensure that the purpose of the test was clear to those taking it, turned out to be effective. Some 90 per cent correct G responses were obtained in response to the concrete items, while the one item which gave the lowest G percentages might well, by its nature, have been considered to be an abstract item.

rate payer, voter, trade unionist . . .

We could then assume that the more widely spread response pattern to the abstract items indeed reflected the major hypotheses on which the research was based.

There remain the principal findings and their implications for education and the functioning of the media. Briefly the pattern of GPNT responses (Table 2) changes in the following ways as we go through the groups tested from graduates to further education students:

(i) a fall in the percentage of G responses;
(ii) a rise in the percentage of N and T responses;
(iii) a similar, but less marked rise in P responses;
(iv) low G responses generally;
(v) high N and T responses from the F.E. group.

There is then some intellectual confusion among the educationally least sophisticated young adults and one wonders at its possible restricting influence on the effectiveness of much of the verbal and textual learning characteristic of upper secondary and lower further education. We must suggest at this point that training in clear thinking might improve the situation. Work already carried out in training judgment (Peel, 1973, Chapter VI) might well be adapted to this need.

As to the media, a knowledge of the above findings and a consideration of their effects would appear to be desirable in relation to editing and programme planning.

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APPENDIX

A TEST OF MEANING PREFERENCES

(keyed for reference)

Each item consists of three notions placed in the top line. Beneath are four other terms. Select and put a circle round the *one* from the second list, which best expresses the overall meaning of the first three notions.

C 1. *apple, pear, plum*
select from:
orange, fruit, ripe, Worcestershire orchard. (TGNP)
C 2. *dog, cat, horse*
select from:
animal, friendly, pet lover, rabbit. (GNPT)
C 3. *flower, cabbage, grass*
select from:
fresh, country garden, hedge, plant. (NPTG)
C 4. *beef, cod, pork*
select from:
food, lamb, good meal, steak. (GTNP)
A 5. *charity, sympathy, tolerance*
select from:
lacking in some people, generosity, humanity, relief of poverty. (NTGP)
C 6. *car, van, bus*
select from:
British Leyland, train, vehicle, fast. (PTGN)
A 7. *defeat, vain attempt, flop*
select from:
deserving sympathy, failure, lost game, wild goose chase. (NGPT)
C 8. *rain, snow, wind*
select from:
Christmas weather, cold, weather, fog. (PNGT)
A 9. *boom, affluence, well-being*
select from:
thriving life, prosperity, privilege, commercial success. (TGNP)
A 10. *pastime, recreation, outing*
select from:
amusement, excursion, healthy, cinema. (GTNP)
A 11. *outcaste, rebel, solitary*
select from:
Hereward the Wake, non-conformist, critic, unhappy. (PGTN)
C 12. *house, school, hospital*
select from:
college, detached, well built, building. (TPNG)

C 13. *chair, dressing table, stool*
select from:
well made, Queen Anne, furniture, wardrobe. (NPGT)
A 14. *murder, aggression, exploitation*
select from:
fascism, detestable, suppression, inhumanity. (PNTG)
A 15. *evolution, reorganisation, differentiation*
select from:
co-ordination, systematic change, emergence of the new society. (TGPN)
A 16. *stamina, thrust, vigour*
select from:
power, athletic drive, to be admired, capacity. (GPNT)
A 17. *disloyalty, passive resistance, desertion*
select from:
ship's mutiny, infringement, disobedience, necessary in some instances. (PTGN)
C 18. *rate payer, voter, trade unionist*
select from:
important, adult, member of Parliament, Hugh Scanlon. (NGTP)
A 19. *inventory, file, record*
select from:
card index, necessary in a large organisation, Domesday Book, list. (TNPG)
C 10. *river, lake, rain*
select from:
water, reservoir, clear, Lake District. (GTNP)

NOTE: C items are concrete; A are abstract.

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SOCIAL CLASS AND SEX CONTRASTS IN VERBAL PROCESSING STYLES

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SUMMARY. It was hypothesised that specific styles or verbal processing would be characteristic of 96 high school students drawn from different social class/sex groups. Such distinctive patterns of functioning, it was posited, could be largely explained by earlier socialisation experiences. Individual structured interviews were transcribed verbatim and six dimensions of verbal processing examined: categories of processing; modes of expression; verbal content; ideational fluency; category breadth; and conceptual preference. Discriminant function analysis, extended and supplemented by analysis of variance, was used to test the hypothesis of style-specific modes of functioning. Middle-class boys and girls displayed similar overall verbal strategies: discriminating, tentative, abstract and person-oriented. Middle-class girls, however, preferred comparing/evaluating modes, while middle-class boys used describing/explaining ones. Working-class boys and girls were generally non-differentiating and non-discriminating and showed a distinct preference for closed-categorical concepts. The notion of style-specific patterns of verbal processing for the criterion groups was supported for social class but only partially for sex.

INTRODUCTION

THE notion that language deficits implied cognitive deficits had considerable currency in the 1960s. Yet this view was not firmly based. Studies which analysed the speech product to infer cognitive processing, rather than to determine the structural and lexical features of language, were rare indeed. The most notable exceptions were studies by Olim *et al.* (1965, 1967) of the verbal socialisation strategies used by middle-class and working-class mothers. The middle-class mode was more discriminating, information packed, diversified, flexible, and abstract than the working-class mothers' verbal behaviour. Although the seventies saw the notion of ' deficit ' replaced by ' difference ', the basis of change seemed to have a social-political base rather than an empirical one.

In fact, studies on the content of verbal products which appeared in the seventies continued to suggest qualitative advantages for middle-class speech. For example, Cook (1971) in analysing mothers' speech, found that middle-class mothers, relative to working-class mothers, displayed an awareness of hypothetical dimensions and alternative modes of interpreting information. Similar studies by Robinson and Rackstraw (1972a, 1972b), Henderson (1970) and Turner and Pickvance (1971) revealed striking social class contrasts in terms of level of generality or abstraction, and the degree of explicitness and precision in language use.

The studies which seemed to support the Bernstein-derived hypothesis of socialisation strategies influencing verbal modes largely emanated from the United Kingdom. At the same time, a spate of studies in the United States strongly attacked the hypothesis but provided scant evidence to underpin the alternative position (e.g. Labov, 1970; Shuy, 1971). There would seem, therefore, to be a need for further empirical exploration of the Bernstein-derived postulates of social class differences in verbal processing styles, especially on more neutral territory.

As the debate on social class issues has decreased within society at large as more overt political support has been given to the notion of equalising educational opportunity, the ground has shifted somewhat to focus on sex differentials and discriminations operating within the classroom. Again, the theoretical basis for considering this problem has generally been socialisation theory (e.g. Mischel, 1970). It seems logical to expect, therefore, on the basis of both social class and sex, that different modes of verbal processing could be operative for each sex within each class.

There is some evidence to support this hypothesis on individual dimensions of functioning but not in overall orientation or general verbal processing style. Hawkins (1971), for example, on the dimension 'fluency in oral story telling' found that working-class girls were more fluent than any other groups and that middle-class girls were more fluent than middle-class boys. Brandis and Henderson (1970) reported that middle-class mothers were less ready to give explanations to girls than to boys. The consequences of this for the development of verbal processing styles could be critical in both cognitive and linguistic terms. Britton (1969), while analysing the speech used by lower middle-class West Indian girls and Londoners, identified an 'expressive' verbal style, but found that boys tended to seek explicitness and precision more than girls did. The possibility seems to exist, therefore, for exploring both the social class and sex dimension in verbal processing styles within the framework of socialisation theory argued by Bernstein (1971), viz., that earlier socialisation experiences, filtered through familial social structures, role relationships, social control strategies, and verbal-cognitive 'press' operating within the home setting will tend to produce distinctive patterns of verbal processing.

The aim of this study, therefore, was twofold: firstly, to follow up the discrepant findings in the literature on social class and sex differences in various areas of verbal functioning, and, secondly, to focus on several dimensions of verbal behaviour operating *together* to form a distinctive pattern or style of processing and to contrast these patterns for both social class and sex groups.

METHOD

Sample

Students were drawn from four Melbourne metropolitan high schools. The Lancaster-Jones (1967) classification of the socio-economic and ethnic rankings of Melbourne suburbs was used as the basis for defining the middle-class or working-class composition of the four participating schools from which equal numbers of both sexes were drawn.

In addition, in-depth questionnaire data on life style, based on Keeves (1970), was used to validate the SES classifications. The composition of the sample is shown in Table 1.

TABLE 1

SOCIO-ECONOMIC/SEX/LIFE STYLE COMPOSITION OF THE SAMPLE

School	Social Class	Sex	Number	SES/Life Style Scale
A	Working-class	Female	24 (44)[a]	2·49[b]
B	Working-class	Male	24 (47)	3·34
C	Middle-class	Female	24 (62)	5·70
D	Middle-class	Male	24 (53)	6·00
Total			96 (206)	

[a] Numbers in brackets indicate the pool of subjects from which random selections were made.

[b] A nine-point scale was devised, nine indicating the uppermost end of scale, e.g. in terms of opportunities for speaking and learning in the home; encouragement for thinking and discussion.

The Verbal Processing Style Measures

The aspects of verbal processing style considered to be important in the verbal planning strategies of middle-class and working-class students were largely derived from theoretical papers by Bernstein (summarised in his 1971 book) and empirical studies by Olim *et al.* (1965). Since few existing schemes for coding oral language protocols could be directly applied to the research problem undertaken in this study, it was necessary to adapt and to modify existing schemes and to develop verbal content, ideational fluency, category breadth, and conceptual preference measures by entirely empirical procedures, always aligned, nonetheless, to a theoretical rationale. The measures derived from a structured interview schedule are summarised in Table 2, together with brief explanations of their meaning. The feasibility and reliability of this scoring system were checked by discussion with other researchers in the field, and by a comparison of the independent classification of two judges. The interview schedule from which the measures were derived is detailed in Poole (1973). Language was elicited through the use of concrete pictorial stimuli together with questions on school experience and social issues (Poole, 1973, pp. 369-371). The schedule sought to tap descriptive, reflective, and increasingly abstract language styles. Each interview was tape-recorded and verbatim transcripts compiled. The stimuli, *per se*, were considered neither to advantage nor disadvantage either social class group.

Multiple discriminant function analysis was used to test the hypothesis that: the social class/sex groups do not differ on the verbal processing style variables—individually or in linear combination.

This analysis, through choice of original variables, enabled overall strategy differences in patterns of verbal functioning to be compared for subjects in the two middle-class and working-class groups and for the sex groups. Recourse was made to the Cooley and Lohnes (1971) Central Limit Theorem of probable normality of discriminant functions, even if some of the component variates could not be judged normal, as is more likely to be the case in freely elicited oral language data.

To test the assumption of homogeneity of group dispersions, Box's (1949) generalised test of homogeneity of variance was used. The result obtained for this test was:

$$\text{Test of } H_1 : \text{Box's } M = 182{\cdot}8\ (F = 1{\cdot}15,\ 459/17841,\ P > {\cdot}05)$$

Since the difference in dispersions was not significant, it was assumed that the four groups were from populations with a common dispersion.

The significance of the group separations was tested by means of the criterion in a multiple discriminant analysis using all 17 verbal process variables. This analysis yielded a highly significant differentiation among the groups:

$$\text{Wilk's Lambda} = 0{\cdot}20\ (F = 3{\cdot}15,\ 51/227,\ P < {\cdot}0001).$$

The hypothesis that the social class/sex groups had similar verbal processing styles can therefore be emphatically rejected. In all, 79·7 per cent of the generalised variance-covariance matrix was accounted for by the three discriminant functions.

Rao's (1952, p. 373) chi-square test was used to determine the significance of each of the three discriminant functions. The results obtained for these tests indicated that only the first two functions were significant. Some 72·5 per cent of the generalised variance of the ungrouped variance-covariance matrix was accounted for by the two significant discriminant functions.

The discriminant function weights appear in Table 3. The nature of the group differences can be examined, then, by considering the correlations between the discriminant functions and the original variables (Table 4), and by plotting the group centroids (Figure 1), thereby revealing a clear separation of the groups on the basis of social class/sex.

TABLE 2

MEASURES OF VERBAL STRATEGIES

Dimension	Variable	Meaning of High Score	Examples
Categories of Processing (information processing styles incorporating dimensions—differentiations and discriminations—and integrating rules)	Differentiation	High ability to abstract dimensions	cliff-face
	Discrimination	High ability to perceive attributes of dimensions	precipitous cliff-face
	Integration	High complex organising schemata	moral ambience
Modes of Expression (preference for categories such as statements, descriptions, or evaluations; range increases in complexity from simple statement to reflection over alternatives)	Stating/Designating	High tendency to name or state facts, beliefs, conclusions	Sport was popular
	Describing/Explaining	High tendency to describe and/or explain an event, fact or perspective	Gravel playing-fields
	Comparing/Evaluating	High tendency to compare or evaluate two or more processes, objects, actions for their value etc.	Pressure to succeed is greater here
Verbal Content (features which distinguish the content of speech samples along dimensions such as originality, abstraction, reference to self)	Originality	High use of unusual and/or figurative imagery	rock eroded into stalagmite formations
	Personal reference	Frequent reference to self and/or one's own perspectives	the sea is a comfort to me
	Abstraction/Synthesis	Ability to abstract properties and relate them	serenity, tranquillity
	Exophoric features	High use of context-bound words	here, there, that one
	Tentativeness	Highly tentative assessments indicating reflection and lack of absolutism	I'd say the ocean was pretty deep
Ideational Fluency (subjects ability to generate numerous hypotheses)	Ideational fluency	High ability to generate alternative hypotheses in relation to questions	We've all got enquiring minds; we like to mix; we like to serve society etc.
Category Breadth (number of arguments and number of alternative perspectives a subject can generate on a specific topic)	Number of arguments	High availability of arguments, viewpoints	Survival, ambition, personal satisfaction, I suppose
	Number of perspectives	Able to direct attention to a number of different kinds of component hierarchies in the unit under attention	Probably no-one looks at things today but . . . and then . . .
Conceptual Preference (preferred response pattern; reasons given in answering questions were classified according to abstract, dogmatic or personal orientation)	%Abstract	Ability to abstract general principles or organising framework	Well if we broke promises, contractual rules would disappear, chaos would reign, civilisation fragment
	%Person-oriented	Ability to perceive situations and the like in terms of consequences to persons as against status or role	We need to stress personal rehabilitation, not punitive philosophies
	%Closed-categorical	High use of dogmatic, closed, or categorical statements. Certainty of viewpoint and tendency to impose value-stance	Well it's right to punish them, it's tradition isn't it?

TABLE 3

DISCRIMINANT ANALYSIS: DISCRIMINANT FUNCTION WEIGHTS ON VERBAL PROCESSING STYLE VARIABLES

Variable	Discriminant Function		
	I	II	III
Categories of Processing			
Differentiation	·03	-·09	-·01
Discrimination	-·02	·06	·06
Integration	-·12	·24	-·46
Modes of Expression			
Stating/Designating	-·13	-·31	-·06
Describing/Explaining	-·13	-·23	-·03
Comparing/Evaluating	-·15	-·31	-·06
Verbal Content			
Originality	·34	-·06	·39
Personal Reference	-·35	-·59	-·19
Abstraction/Synthesis	-·35	·43	-·37
Exophoric Features	-·18	-·06	·02
Tentativeness	·02	·02	-·03
Ideational Fluency	-·03	·12	-·50
Category Breadth			
Number of arguments	-·39	-·28	·10
Number of perspectives	·62	·22	-·43
Conceptual Preference			
%Abstract	·05	-·00	-·00
%Person-oriented	·04	-·00	-·00
%Closed-categorical	-·04	·01	·00

TABLE 4

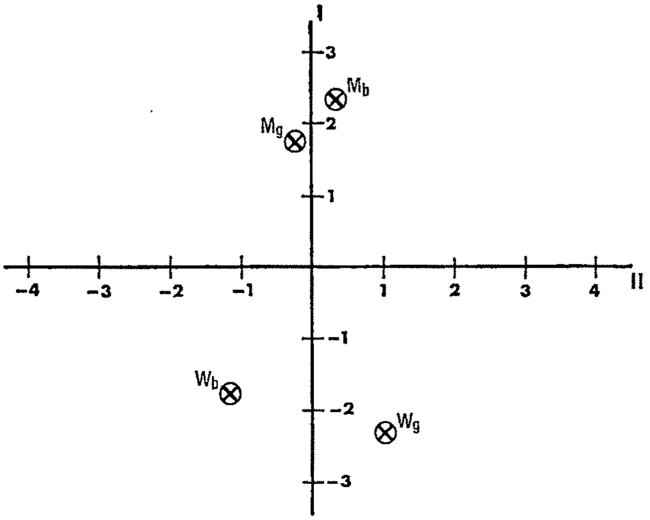
DISCRIMINANT ANALYSIS: CORRELATIONS WITH ORIGINAL VERBAL PROCESSING VARIABLES

Variable	Discriminant Functions		
	I	II	III
Categories of Processing			
Differentiation	·28	-·09	·20
Discrimination	·37	·07	·26
Integration	·20	·12	-·47
Modes of Expression			
Stating/Designating	-·10	-·41	·22
Describing/Explaining	·17	·69	·14
Comparing/Evaluating	·00	-·07	-·40
Verbal Content			
Originality	·28	-·19	·21
Personal Reference	·20	-·19	·02
Abstraction/Synthesis	·27	·20	-·29
Exophoric Features	-·27	-·16	·07
Tentativeness	·31	·16	-·15
Ideational Fluency	·09	·05	-·52
Category Breadth			
Number of arguments	·29	·02	-·28
Number of perspectives	·13	·18	-·41
Conceptual Preference			
%Abstract	·83	·04	-·08
%Person-oriented	·46	-·16	·10
%Closed-categorical	-·71	·08	·12

FIGURE 1

GROUP DEVIATION CENTROIDS FOR ORIGINAL DISCRIMINANT FUNCTIONS: VERBAL STRATEGY ANALYSIS

(W = Working-class; M = Middle-class; g = Girls; and b = Boys)



The correlation coefficients in Table 4 indicate that group separation along the first discriminant functions was determined largely by five variables: conceptual preference for an abstract mode (0·83) and an avoidance of the closed-categorical mode of verbal processing (−0·71); person-oriented conceptual preference (0·46); discrimination in verbal processing (0·37); and tentativeness in verbal content (0·31). High scores on abstraction, person-orientation, discrimination, and tentativeness and low scores on closed-categorical statements therefore resulted in high scores on Function I. Category breadth (number of arguments, 0·29) and verbal content (originality, 0·28; abstraction/synthesis, 0·27; and exophoric features, −0·27) made less important, but interesting, contributions to group separation on this discriminant function, falling just short of the ·30 criterion for function interpretation.

The second discriminant function, while not as strong as the first, related only to modes of expression, involving a distinct preference for the describing/explaining dimension (0·69) and an avoidance of the stating/designating mode of verbal expression (−0·41).

The co-ordinates of the group centroids on Discriminant Function I show the groups ordered largely in terms of social class; that is, the two middle-class groups (M_g and M_b) were discriminated from both working-class groups (W_g and W_b).

There is, in addition, a consistent sex ordering within social class divisions along Function I, W_g scoring lower than W_b, with a similar pattern exhibited for the middle-class groups, i.e. M_g scoring lower than M_b, but the differences are not large. The major result is that both middle-class groups obtained the higher scores on Function I.

The group co-ordinates on the second discriminant functions do not appear to relate generally to either social class or sex. The groups are ordered, in terms of highest negative group centroids, working-class boys (W_b, −1·11), middle-class girls

(M_g, −0·20), middle-class boys (M_b, 0·31) and working-class girls (W_g, 1·00). The centroids of the two middle-class groups tend to cluster together but the two working-class groups differ, suggesting a sex difference within the working-class on this function. Working-class girls have the highest discriminant scores on the second function, and working-class boys the lowest.

To define distinctive verbal processing styles for the four groups the two discriminant functions can be considered together. For middle-class girls (M_g) the pattern of verbal strategies is characterised by high scores on Function I and somewhat lower scores on Function II; for middle-class boys (M_b), high scores on Function I and fairly high scores on Function II. The characteristic verbal strategies of working-class girls (W_g) are defined by low scores on Function I and high scores on Function II, that of working-class boys (W_b) by low scores on Function I and low scores on Function II. There seem, therefore, to be clearly defined verbal strategies exhibited by the four groups, although the two middle-class groups seem to function along more similar dimensions than the two working-class groups.

To enable finer discriminations to be made among the groups, and as supporting evidence for the overall differences in verbal processing styles which emerged from the discriminant function analysis, two-way analyses of variance were computed.

A summary of the 17 F-tests calculated for each of the social class, sex, and interaction effects on each of the verbal strategy variables is presented in Table 5. A table of t-test inter-group comparisons (Table 6) is also included to highlight the specific differences and similarities in the verbal strategies used by the four groups.

TABLE 5

ANALYSIS OF VARIANCE COMPARISONS OF SOCIAL CLASS/SEX GROUPS ON VERBAL PROCESSING STYLE VARIABLES

	Mean Square (F-ratio)†			
Variable	Social Class	Sex	Social Class × Sex	Within
Categories of Processing				
Differentiation	384·00 (3·93)*	165·38 (1·69)	0·00 (0·00)	97·62
Discrimination	2410·01 (7·88)**	404·26 (1·32)	283·59 (0·93)	306·05
Integration	7·04 (3·66)*	6·00 (3·12)	0·38 (0·20)	1·93
Modes of Expression				
Stating/Designating	433·50 (1·12)	1426·04 (3·69)*	900·38 (2·33)	385·99
Describing/Explaining	364·26 (2·64)	294·51 (2·16)	2156·51 (15·63)**	137·97
Comparing/Evaluating	10·67 (0·04)	368·17 (1·41)	368·17 (1·41)	261 90
Verbal Content				
Originality	4·59 (4·07)*	3·01 (2·67)	0·26 (0·23)	1·13
Personal Reference	1·04 (2·14)	0·38 (0·77)	0·38 (0·77)	0·49
Abstraction/Synthesis	2·04 (5·33)*	0·67 (1·74)	0·04 (0 11)	0·38
Exophoric Features	16·67 (4·62)*	0·67 (0·19)	1·50 (0·42)	3·61
Tentativeness	894·26 (6·78)**	55·51 (0·42)	29·26 (0·22)	131·99
Ideational Fluency	2·04 (1·03)	7·04 (3·55)*	1·50 (0·76)	1·99
Category Breadth				
Number of arguments	19·26 (5·77)**	1·76 (0·53)	0·84 (0·25)	3·34
Number of perspectives	2·04 (1·64)	4·17 (3·34)	0·00 (0·00)	1·25
Conceptual Preference				
%Abstract	44850·26 (69·04)**	319·01 (0·49)	6·51 (0·01)	649·63
%Person-oriented	7089·84 (13·20)**	1100·26 (2·05)	162·76 (0·30)	536·97
%Closed-categorical	17604·71 (41·52)**	234·38 (0·55)	234·38 (0·55)	424·02

† Degrees of freedom 1,92. * P<·05. **P<·01.

TABLE 6

t-TESTS† OF DIFFERENCES BETWEEN SOCIAL CLASS/SEX GROUPS ON VERBAL PROCESSING STYLE VARIABLES

Variable	Groups Compared					
	W_g *vs.* W_b	W_g *vs.* M_g	W_g *vs.* M_b	W_b *vs.* M_g	W_b *vs.* M_b	M_g *vs.* M_b
Categories of Processing						
Differentiation	0·92	1·40	2·32*	0·48	1·40	0·92
Discrimination	0·13	1·30	2·80**	1·17	2·66**	1·49
Integration	−0·94	1·66	0·10	2·60**	1·04	−1·56
Modes of Expression						
Stating/Designating	2·44**	0·33	0·61	−2·11*	−1·83	0·28
Describing/Explaining	−3·83**	−1·65	0·11	2·19*	3·94**	1·75
Comparing/Evaluating	0·00	0·98	−0·70	0·98	−0·70	−1·68
Verbal Content						
Originality	1·49	1·77	2·58**	0·27	1·09	0·82
Personal Reference	1·24	1·65	1·65	0·41	0·41	0·00
Abstraction/Synthesis	−1·17	1·40	0·70	2·57**	1·87	−0·70
Exophoric Features	0·76	−1·06	−1·22	−1·82	−1·98*	−0·15
Tentativeness	−0·79	1·51	1·38	2·30*	2·17*	−0·13
Ideational Fluency	−0·72	1·33	−0·61	2·05*	0·10	−1·95*
Category Breadth						
Number of arguments	−0·16	2·05*	1·19	2·21*	1·34	−0·87
Number of perspectives	−1·29	0·90	−0·39	2·20*	0·90	−1·29
Conceptual Preference						
%Abstract	0·42	5·80**	6·37**	5·38**	5·95**	0·57
%Person-oriented	1·40	2·96**	3·58**	1·56	2·18*	0·62
%Closed-categorical	−1·05	−5·08**	−5·08**	−4·03**	−4·03**	0·00

† Degrees of freedom 92. * $P<\cdot05$. ** $P<\cdot01$.

An F-ratio significant at the 0·05 level of confidence or better was obtained for 11 variables that made a major contribution to the separation of the social class groups on discriminant Functions I and II, for only two variables on the basis of sex, and one variable which showed interaction effects between social class and sex. The dominant factor in group separation relative to modes of verbal processing styles seems therefore to hinge mainly on social class.

The most distinctive features of the verbal strategies of M_b were their marked preference for using differentiation and discrimination as categories of processing; a more frequent usage of the describing/explaining mode of expression; verbal content showing originality and an avoidance of exophoric and tentative verbal attributes; a distinct preference for abstract and person-oriented verbal strategies as opposed to closed-categorical ones. The pattern of verbal processing was not markedly different for M_g. There was a similar facility with differentiating and discriminating but a more marked capacity for integration; other variables which contributed to the middle-class girls' verbal strategy style were minimal use of the stating/designating and describing/explaining modes of expression, and more frequent use of the comparing/evaluating mode; verbal content low on exophoric features and high on tentativeness; high ideational fluency; broad category breadth (arguments and perspectives); and conceptual preference showing abstract and person-oriented features as against closed-categorical ones.

The verbal strategies of W_b appear to reflect categories of processing low in discrimination and integration; modes of expression high on stating/designating and low on describing/explaining; verbal content low on abstraction/synthesis and tentativeness; low ideational fluency; narrow breadth (both arguments and perspectives); and a marked preference for closed-categorical statements. The verbal strategies of W_g exhibit low levels of differentiation and discrimination; a marked preference for describing/explaining; low originality and narrow category breadth (arguments); and conceptual preference high on the closed-categorical dimension and low on abstraction and person-orientation.

It seems, then, on the basis of the results of the two-way analyses of variance that support is added to the pattern of differences among the groups described by the discriminant solution for verbal strategy variables. Whereas the discriminant function analysis took account of the joint operation of the 17 verbal strategy measures and ordered the groups mainly in terms of social class, the F-tests demonstrated specific aspects of modes of verbal functioning which highlighted some sex differences as well.

Distinctive verbal strategies, characteristic of social class groups (W_g and W_b *vs.* M_g and M_b) and, chiefly within the working-class, of sex group differences (W_g *vs.* W_b) in modes of expression, were revealed by this ancillary analysis.

SUMMARY AND DISCUSSION

The co-ordinates of the group centroids on Discriminant Function I show the groups ordered largely on the basis of social class: M_g and M_b being separated from W_g and W_b. On Discriminant Function II, the ordering of group co-ordinates does not appear to relate generally to either social class or sex. Groups M_g and M_b tend to cluster together, but groups W_g and W_b differ, suggesting a sex difference within the working-class on this function. The discriminant analysis was supplemented by analysis of variance to assist in the delineation of group-specific styles of verbal processing.

The most distinctive features of the verbal styles of middle-class boys (M_b) were a marked preference for differentiation and discrimination as categories of processing; more frequent usage of the describing/explaining mode of expression; verbal content showing originality and an avoidance of exophoric and tentative verbal attributes; and a distinct preference for abstract and person-oriented verbal strategies as opposed to closed-categorical ones.

The pattern of verbal processing was not very different for middle-class girls (M_g). A similar facility with differentiating and discriminating was evident, but M_g exhibited a more marked capacity for integration. Other variables which contributed to the overall verbal processing strategies of M_g were: minimal use of the stating/designating and describing/explaining modes of expression and more frequent use of the comparing/evaluating mode; verbal content low on exophoric features and high on tentativeness; high ideational fluency; broad category breadth (arguments and perspectives); and a preference for abstract and person-oriented concepts in contrast to closed-categorical ones.

The degree of differentiation and discrimination evident in the verbal processing categories of M_b and M_g lends support to Bernstein's (1961) thesis that the middle-class elaborated code user systematically constructs categories and progressively differentiates them, often into a matrix of complex relationships (integrations). This third phase was apparent in the verbal processing style displayed by M_g. The results for middle-class groups on the three categories of processing, differentiation, discrimination, integration, were generally consistent with those reported by Hess and Shipman (1966) for oral material, and by Kiellerup (1972) for written material, i.e. middle-class children obtained higher scores than working-class children on all three dimensions.

Preferred modes of expression for M_b were description and explanation while M_g

preferred comparison and evaluation. Although not directly comparable, the results show some similarity with those reported by Schatzman and Strauss (1955) and Strauss and Schatzman (1955). Middle-class groups do impose an organisational framework in an open verbal situation. That M_b prefer a descriptive/explanatory mode may relate to their preference in the cognitive domain for descriptive/analytic and physical concepts (Poole, 1975). That is, M_b, in describing and explaining, are abstracting external properties. M_g, on the other hand, prefer to compare and evaluate. Again, this may relate to their preference for categorical-inferential concepts; or to their orientation towards personal attributes. Both these tendencies might lead them to be more evaluative. Or, alternatively, the socialisation processes operating on the M_g may predispose her to look for comparative yardsticks as a means of reducing risk-taking (e.g. making independent statements) without a point of reference.

The infrequent occurrence of exophoric features for M_b and M_g is consistent with results reported by Hawkins (1971). The findings on tentativeness, while consistent with Loban's (1963) for M_g, are somewhat surprising for M_b. It would seem that M_b do not display tentativeness in the selection of words. M_g, on the other hand, tend to indicate tentativeness in word selection. That M_b scored more highly on originality than M_g may be related to their preference for the descriptive mode. M_g, however, were more fluent: generating more ideas, arguments and alternative perspectives. Again, this might relate to their comparing/evaluating tendencies. To compare, one must generate a number of possible and different hypotheses. An alternative explanation may be that girls are more fluent and inclined to put forward many ideas. Boys, on the other hand, may put forward fewer ideas but take more time explaining and propounding their viewpoints. The results reported by Cook (1971) for middle-class mothers lend some support to the findings for M_g on awareness of alternatives (category breadth).

Both middle-class groups displayed a marked preference for abstract concepts and person-oriented concepts. These results find support from a number of studies (e.g. Schatzman and Strauss, 1955; Siller, 1957; John, 1963; Olim *et al.*, 1965; Bernstein, 1971). The verbal processing styles of both middle-class groups are not characterised by closed-categorical statements. One may infer that the socialisation strategies alluded to earlier (e.g. rational-cognitive for middle-class *vs.* imperative-normative for working-class) are partly responsible for this more open approach to information processing. Similarly, the maternal answering strategies reported by Robinson and Rackstraw (1972a, 1972b) may have been important in the development of abstract and person-oriented modes by M_b and M_g in preference to dogmatic or closed categories: an outgrowth of curbed curiosity for working-class children because of insufficient or inappropriate feedback to, for example, " Wh " questions.

Turning next to the two working-class groups, the verbal strategies employed by working-class boys (W_b) were low on discrimination and integration; high on stating/designating modes but low on describing/explaining; low on abstraction/synthesis and tentativeness; low on ideational fluency (ideas, ability to generate arguments, and perspectives, i.e. narrow category breadth); and high on closed-categorical statements. Many of the attributes displayed by W_g were similar: low levels of differentiation and discrimination; preference for describing/explaining; low originality and narrow category breadth (arguments); and conceptual preference high on closed-categorical statements but low on abstract or person-oriented ones.

Both working-class groups lacked at least two categories which facilitate the explicit classification and discrimination of persons, states and objects—differentiations, discriminations, and integrations. These results are consistent with those reported by Schatzman and Strauss (1955); Stodolsky (1965); Henderson (1970); and

Kiellerup (1972), i.e. generally less specific and discriminating verbal behaviour for working-class groups. These basic categories of verbal processing—differentiation, discrimination, integration—may well be important to the transmission of particularistic or universalistic meanings, a distinction made more recently by Bernstein (1970, 1971). If integrating processes are generally absent it may be difficult for the working-class to communicate more universalistic meanings. Further, for the working-class groups it seems that the meaning potential alluded to by Halliday (1970), i.e. the range of semantic options available to the speaker in the context of a specific situation, is not integrated into a systematically related network. Consequently, the verbal processing styles of working-class groups appear to be global, non-differentiated, and lacking in organisation. The results of the present study suggest, in sharp contrast to both middle-class groups, this style of operation is characteristic of both W_b and W_g.

An interesting finding is that W_b are high on stating/designating and low on describing/explaining, while W_g are high on this second mode of expression. Possibly, as a result of their mothering role (Bernstein, 1971), W_g are required to describe and explain situations and events to their siblings more frequently than is the case for W_b. In contrast, the working-class male stereotype may foster stating/designating behaviour. In terms of sub-cultural mores, statements (often categorical) by working-class males may be accepted as ' facts ' without explanation or challenge.

In terms of verbal content, neither working-class group has a predominant characteristic other than, for W_g, low originality; for W_b, low abstraction/synthesis, and low tentativeness. For the W_b, the lack of tentativeness may relate directly to a preference for stated, unchallenged assumptions or designations, unhesitatingly and confidently delivered (cf. Loban, 1963, 1966). The low abstraction/synthesis scores for W_b are in accord with the studies and results cited above for categories of processing. W_g did not use figurative or original images. Nor did W_b or M_g. Loban found this dimension to be lacking in the speech of nearly all his respondents. In the present study, originality was only evident in the verbal content of M_b. Scores on ideational fluency were lower for W_b than for W_g. Both sex factors and socialisation practices can be offered as possible explanations of this difference.

The finding that both working-class groups revealed limited perspectives in argument and showed a distinct preference for closed-categorical statements is given support in numerous theoretical and empirical papers (e.g. Holstein, 1968; Kohlberg, 1969; Hess, 1970; Bernstein, 1971). To refer back to a series of ' socialisation clusters ': coercive social control; inhibition of curiosity; insufficient verbal interaction; inadequate information structuring skills; confusion of bald statement and causation in cognitive interchange—these, and similar issues can be offered as partial explanations for the emergency of limited perspectives and closed-categorical statements. Indeed these two characteristics seem to be dominant features in the verbal processing styles adopted by working-class groups.

In summary, then, the overall verbal processing styles of the social class/sex groups are presented in Table 7.

IMPLICATIONS FOR TEACHING

The findings of the study, summarised and discussed above, would seem to suggest important implications for teaching. Implicit in the present research design and findings is the notion that some styles of verbal processing are more effective than others; that is, the stance taken here values the range of information processing options available to students who exhibit modes of functioning which are flexible, analytic, integrative, and so on. The disturbing question, however, is whether there is adequate reason to assume that these styles of intellectual processing are more

TABLE 7

VERBAL PROCESSING: STYLES OF FUNCTIONING OF THE SOCIAL CLASS/SEX GROUPS

Group	Verbal Strategies: Characteristics
Working-class girls (W_g)	Low differentiation and discrimination High describing/explaining mode Low originality Narrow category breadth (arguments) Conceptual preference—closed-categorical
Working-class boys (W_b)	Low discrimination and integration High stating/designating Low describing/explaining Low abstraction/synthesis Low tentativeness Low ideational fluency Narrow category breadth—arguments —perspectives Conceptual preference—high on closed-categorical
Middle-class girls (M_g)	High differentiation and discrimination Moderate integration Low stating/designating High comparing/evaluating Low exophoric High tentativeness High ideational fluency Broad category breadth—arguments —perspectives Conceptual preference: %person-oriented %abstract
Middle-class boys (M_b)	High differentiation and discrimination High describing/explaining mode High originality Low exophoric Low tentativeness Conceptual preference for—person-oriented concepts —abstract concepts

effective (in the classroom and in non-school contexts) or whether it is simply that they are *different* (but functionally adequate to meet diverse and complex verbal tasks). If they are more *effective*, the assumption made by the present investigator—which is undoubtedly a heavily value-laden one—is that it is desirable and necessary for some students to change aspects of their verbal processing styles so that they may gain access to a wider range of verbal options and strategies. This assumption could be based on a false premise, or on a value base not shared by others. For instance, it could be argued, equally convincingly, that the verbal processing styles used by the social class/sex groups in the present study are merely *different* and that to attempt to change some aspects of processing would be an infringement of the rights of such children and a denial of the validity of their own culture. Many educators and sociologists, for example, would argue that society as a whole should change; that schools should eschew their achievement and middle-class value orientation; that schools should take cognisance of a more diversified society where a range of verbal processing styles would not only be desirable, but also be necessary to avert monolithic cultural and stereotyped patterns. While the present investigation might be seen as providing some support for this viewpoint, there is also evidence relating to school achievement and job opportunities which demonstrates that those students with competence in verbal processing skills (e.g. fluency, negotiating interviews, explaining viewpoints, evaluating evidence) have a positive advantage in the society at large (e.g. in terms of persuasibility, visibility, self-esteem enhancement, the ability to negotiate in different social contexts). Students with low differentiation and integration, however, are often unable to meet the formal requirements of language demands in the classroom (e.g. accurate descriptive communication, argument synthesis, event reporting, information transfer), let alone the social and vocational tasks of the world of work and leisure.

An explicit assumption made by the present investigator, then, is that it is both appropriate and desirable for all students to have the *opportunity* of gaining *access* to flexible and functional modes of verbal processing, in order that they might better survive in, and negotiate their way through, a highly complex technological and urban society. But how could we achieve this goal or high ideal?

The first direct action could be at the level of teacher education programmes. Student teachers need to be much more aware of the language of the classroom—its style, its functions, its consequences; the language of the child; their own language; the language interchanges and the options these create or curb. Exposure to Barnes (1969) and to Cazden (1972) takes the student part way towards understanding some of the problems involved but much more needs to be done. Teachers have been subjected to fads in education where ' content ' was ' out ' and ' process ' was ' in ', but even then little cognisance was given to the verbal processing dimension of teaching. Another fad, ' linguistic deprivation ', focused teacher attention on structural and lexical dimensions of language rather than on the cognitive functioning and verbal planning displayed in the child's speech (verbal product). The language and thinking relationship is a complex one, but an analysis of the verbal processing styles children use gives us, as teachers, insight into both domains.

Once student teachers are sensitised to the need for developing a range of verbal processing strategies in their pupils, what can they do, in practical terms? Children of both social class/sex groups need to be guided to an increased awareness of new ways of describing and categorising the perceptual world, both material and social (Robinson and Creed, 1968). To this end, professional educators need to provide student teachers with a range of possible ways of assisting children to develop new strategies for representing knowledge (logical, empirical, moral, aesthetic or metaphysical). In addition, children need to be assisted in devising ways of communicating such newly accessed knowledge in verbal modes which are not prescriptive (Robinson, 1972) but so constituted that they can enhance a child's ability to formulate problems verbally, for example in terms of questions, and to evaluate and modify answers through discussion techniques.

In addition, student teachers need to be given the expertise to attempt to provide organisational frameworks within which categories of experience can be articulated. This could involve developing new skills: of observing, perceiving relationships, making comparisons, and organising knowledge into meaningful categories and hierarchies. To do this, a highly verbal classroom environment would be necessary: small group discussion, group problem-solving, role playing in various social and interpersonal contexts.

An experiential approach to teaching may also prove valuable for broadening the verbal processing resources of working-class students and middle-class girls—a need revealed in the present study. Activities, excursions followed by focused discussion (and possibly preceded by suggested observation schedules) could foster the development of a number of verbal processing dimensions; categories of processing; modes of expression; verbal content; ideational fluency; and conceptual preference styles.

Verbal processing styles, in the end, are very personal and idiosyncratic. They help define selfhood, the ' inscape ' of the person. On the other hand, verbal processing styles are the filter through which we transact all our verbal exchanges, from a simple purchasing transaction, to giving directions, to persuading a person to our point of view, to propounding the relative worth of political parties (while at the same time analysing the inconsistencies and gaps in their policy speeches). Can we, then, afford *not* to have a shared repertoire of verbal processing styles transcending social class and sex differences which are flexible, analytic, integrative and evaluative?

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THE DISTRIBUTION OF PIAGETIAN STAGES OF THINKING IN BRITISH MIDDLE AND SECONDARY SCHOOL CHILDREN. II—14- to 16-YEAR-OLDS AND SEX DIFFERENTIALS

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SUMMARY. Continuing a previous study, the proportion of children in a representative sample of 1200 15- to 16- year-olds showing different Piagetian levels of thinking was measured. No increase in the proportion showing formal operational thinking was found beyond the age of 15. On the three tests used a retrospective analysis of both surveys for sex differential showed no increase for girls after 14, while the boys continued for a further year. The pendulum problem showed no sex differential, and the boys indicated level was, on average, the same on all three tests. The girls' performance was substantially lower on the test on spatial relationships, and on the test on volume and density, throughout the age-range 9 to 16.

IN a study previously reported in this *Journal* (Shayer *et al.*, 1976) the Piagetian levels among a representative sample of British children between the ages of 9 and 14 were measured. Representativeness was obtained by comparing the school populations with the norms established by the NFER for the Calvert Non-Verbal Reasoning test. The correlation between this test and the Piagetian Tasks used was sufficiently high (0·55 and 0·63) to allow it to be used to estimate the representativeness of the sample used for the Tasks, but not high enough to act as a replacement. Moreover the purpose of the measure was to use Piaget's behavioural descriptions in order to estimate the suitability of science and mathematics curricula for children of different ages. A Piagetian measure would give the information required; a norm-referenced test would only give the percentile of a child among others of his own age.

Since it is well-known, both by analysis of exam gradings (Forrest, 1971, 1972), and from work on pupils' attitudes to Science (Ormerod with Duckworth, 1975), that science and mathematics make exacting demands on pupils, it was thought particularly desirable to know whether it is possible to count on a steady increase in the proportion of formal operational thinkers in fifth and sixth formers (aged 15 to 18). Previous estimates of the proportion of people of this age showing formal operational thinking have ranged from 32 per cent (Higgins-Trenk and Gaite, 1971; Dulit, 1972; Lawson and Renner, 1974) to 85 per cent (Lengal and Buell, 1972).

Since the 1976 survey referred to above indicated about 24 per cent of the population showing early formal operational thinking at 14, almost any view was possible about development after 14. Thus the present survey aimed to complete the previous work with a further cross-sectional study taken as far as minimum school-leaving age. It could not be taken any further because there would be no way of estimating the level of those who had left the school population. It was also clearly desirable to find if boys develop at the same rate as girls. Thus the data from the previous survey were given a further analysis for boys and girls separately, and are reported here together with the results of this survey.

METHOD

As in the 1976 survey, it was necessary to use two Piagetian group-tests to test enough people for the population estimate to have adequate precision. These were the Class-Tasks II (Volume and Density) and III (Pendulum) which provide indication of the following Piagetian levels: early Concrete-2A; late Concrete-2B; early Formal-3A; and late Formal-3B. The whole of a school year-group was tested in each school, and the representativeness of the school population was estimated by administering the Calvert Non-Verbal Reasoning test to the whole of the first year. Schools were chosen for the surveys only if the catchment area and pupil intake had not changed between the present year and that in which the pupils tested were themselves first year. The schools used were not the same as in the 9-14 (1976) survey.

Nine mixed comprehensive schools were used, ranging in character from small schools in Hertfordshire (city, town, rural and new town) to medium sized schools in rural and city Gloucestershire and large comprehensive schools in suburban Leicester and a Sussex town. The mean Calvert standardised score for the pupils in these schools varied from 97·4 to 102·5.

It was considerably harder to find schools willing to carry out this measure than for the previous survey of younger children. It was necessary to agree to test the fifth-years early in the school year, while the fourth years were tested in summer. Thus the ages of the people in both year-groups overlapped so much that it was decided to pool the results, giving one sample with a range from 15:0 to 15:6 and the other with a range from 15:6 to 16:0.

RESULTS

The percentages of people at a given Piagetian level were obtained from the linear regression of the Piaget level percentage for each school on the Calvert mean for the school. The representative percentage was that corresponding to a Calvert mean of 100. Thus, in obtaining the percentage of boys and girls at the 3A level at mean age 15:3 on Task III, the regression of the 3A and 3B percentages on Calvert scores gave 32·2 per cent at Calvert = 100. From this the 12·6 per cent of pupils who were estimated as 3B was subtracted giving the value of 19·6 per cent which is quoted in Table 1. This method of data analysis allowed an estimate to be made of the sampling error of the measure.

The estimated standard error of regression for the 32·2 per cent at level 3A and above value for boys and girls was 1·4 per cent suggesting confidence limits for the range in which the population mean lies as 32·2 ± 3·1 per cent (Draper and Smith, 1966, pp. 16-23). Some of the sample between 15:6 and 16:0 were in their fourth year while others were in the fifth form. To see if an extra year of schooling made any difference, all of the fourth year results for the pupils between 15:0 and 16:0 were compared with those of the fifth year. The percentages at 3A and above on Task III at Calvert mean 100 were:

Fourth year 31·8; Fifth year 32·5 (see also Appendix).

RESULTS

(a) *Overall survey results*

In Table 1, in order to complete the 9-14 (1976) survey, the boys' and girls' results from this survey were pooled and reported for mean ages 15:3 and 19:9.

TABLE 1

PERCENTAGE OF CHILDREN AT EACH PIAGETIAN LEVEL

Population		Stage of performance in Task II					
(N)	Mean Age	1	2A	2A/2B	2B	2B/3A	3A
(487)	15 years 3 months	0·9	3·2	10·6	25·0	36·0	24·3
(346)	15 years 9 months	0·6	3·8	11·6	32·2	30·3	21·5
		Stage of performance in Task III					
		Below 2B	2B	2B/3A	3A	3B	
(642)	15 years 3 months	14·1	25·9	27·8	19·6	12·6	
(548)	15 years 9 months	15·1	27·1	26·6	17·4	13·9	

(b) *Difference between boys and girls on Tasks I, II and III*

The contents of Tables 2, 3 and 4 were obtained by the same method as was used for Table 1. Table 2 was derived entirely from the 9-14 (1976) survey: Tables 3 and 4 were derived by analysing both surveys by sex. Within each year-group the majority of children did all the tests, but each test was done at a different time of year, and thus the mean ages of the children differ. Each year-group is a different sample.

TABLE 2

Percentage of Children at Different Stages by Task I

			Stage of performance				
(N)	Mean Age	Sex	1	2A	2A/2B	2B	2B+
(610)	13 years 8 months	M	0·2	0·3	9·1	45·9	44·5
(562)		F	0·5	1·6	10·2	47·0	40·8
(1230)	12 years 8 months	M	0·9	2·4	16·0	54·9	25·8
(1122)		F	2·4	6·4	19·1	52·5	19·7
(1060)	11 years 9 months	M	1·9	6·1	25·4	48·8	17·8
(1085)		F	4·0	11·9	34·0	40·4	9·8
(561)	10 years 8 months	M	6·1	8·9	33·3	44·4	7·4
(495)		F	10·0	15·6	37·1	32·8	4·4
(385)	9 years 8 months	M	8·4	13·2	38·0	34·2	6·3
(376)		F	14·1	22·9	38·4	20·3	4·3

TABLE 3

Percentage of Children at Different Stages by Task II

			Stage of performance					
(N)	Mean Age	Sex	1	2A	2A/2B	2B	2B/3A	3A
(179)	15 years 9 months	M	0	4·1	6·9	23·4	32·0	33·7
(167)		F	1·4	2·9	17·7	36·6	25·2	16·3
(255)	15 years 3 months	M	0	3·0	6·3	21·8	40·5	28·4
(232)		F	1·7	0·4	18·0	27·3	35·1	17·5
(689)	14 years 1 month	M	1·0	1·1	13·8	23·6	35·6	24·9
(501)		F	0·6	2·9	17·1	31·6	29·2	18·5
(981)	13 years 1 month	M	1·5	5·2	15·0	29·1	30·9	18·3
(798)		F	2·6	9·0	30·9	27·6	20·3	9·6
(873)	12 years 1 month	M	3·5	7·6	16·0	29·8	28·0	15·2
(852)		F	5·6	10·9	30·6	29·3	15·5	8·1
(545)	11 years 1 month	M	7·4	12·4	29·9	30·4	14·2	5·8
(454)		F	4·9	12·2	45·2	27·5	5·9	4·3
(253)	10 years 0 month	M	9·7	15·3	29·4	34·4	9·3	1·9
(314)		F	13·7	18·8	42·4	19·8	5·3	0

TABLE 4

PERCENTAGE OF CHILDREN AT DIFFERENT STAGES BY TASK III

			Stage of performance				
(N)	Mean Age	Sex	2B⁻	2B	2B/3A	3A	3B
(296)	15 years 9 months	M	16·7	27·4	21·0	18·2	16·8
(252)		F	14·8	22·7	36·7	17·0	8·9
(355)	15 years 3 months	M	13·6	27·4	25·3	18·0	15·7
(287)		F	17·2	22·3	32·0	19·5	9·0
(580)	14 years 4 months	M	33·8	24·7	18·9	14·9	7·7
(517)		F	32·0	21·5	21·5	16·4	8·6
(874)	13 years 4 months	M	35·9	21·8	22·5	14·2	5·7
(683)		F	36·2	22·2	20·8	15·1	5·7
(549)	12 years 3 months	M	40·1	20·2	24·7	11·7	3·3
(597)		F	38·0	15·5	30·2	13·7	2·7

DISCUSSION

The significance of these figures can be seen more clearly in Figures 1, 2 and 3. It will be seen that on Task III (Figure 1) there is no difference between the performance of boys and girls up to and including the 13+ population (mean age 14:4). Task III is the pendulum problem, in which the questions asked relate only to strategies of investigation, and analysis of the observations demonstrated during the test. But in Task II, Volume and Heaviness, questions involving the conservations of Quantity, Weight and Volume, and their relationship to each other in respect of Density, do not only test the child's ability to solve the immediate problem presented, they also depend on the child's previous digestion of experience. In Task III experience is being tested in a very general way by asking the question: Has the child developed certain problem-solving strategies (schemes)? In Task II the test is more specific: Has the child applied such strategies in the past to the basic physical quantities, so that he now knows how to apply the conservations which are relevant to the questions asked? On Task II there is, indeed, a consistent sex differential from age 9 to 16 (Figure 2). Thus one can argue that Task III is a test of the child's basic competencies, and the conclusion to be drawn from the facts would seem to be that up to age 14 there is no difference between boys and girls in the development of operational thinking. The fact that the girls' performance does not increase beyond the age of 14 should be read, then, as a cessation of development in this kind of scientific thinking. Boys appear to develop, much as in earlier years, for a further year until age 15, when they also cease to show any further increase. Since the results for boys are essentially the same on Tasks I, II and III (Figure 3), and coincide with the results for girls on Task III, the lower performance of girls on Tasks II and I has to be read as a deficit peculiar to these areas. The difference on Task I (Figure 4) may be accounted for by the well-established poorer spatial ability of girls. Here the intelligent activity asked for demands working through the previous internalisation of spatial relationships. On Task II a more likely source of the difference is the different interest-patterns of boys and girls. The girls, particularly in early adolescence, have predominantly verbal interests, rather than manipulative-exploratory. If a child is asked a question which requires him to see that consideration of weight/volume relationships is the necessary strategy for solving it, it is much more likely that he will produce this strategy from reflection on previous experience, rather than by an

FIGURE 1

TASK III: PENDULUM. PROPORTION OF BOYS AND GIRLS AT DIFFERENT PIAGETIAN STAGES IN A REPRESENTATIVE BRITISH POPULATION

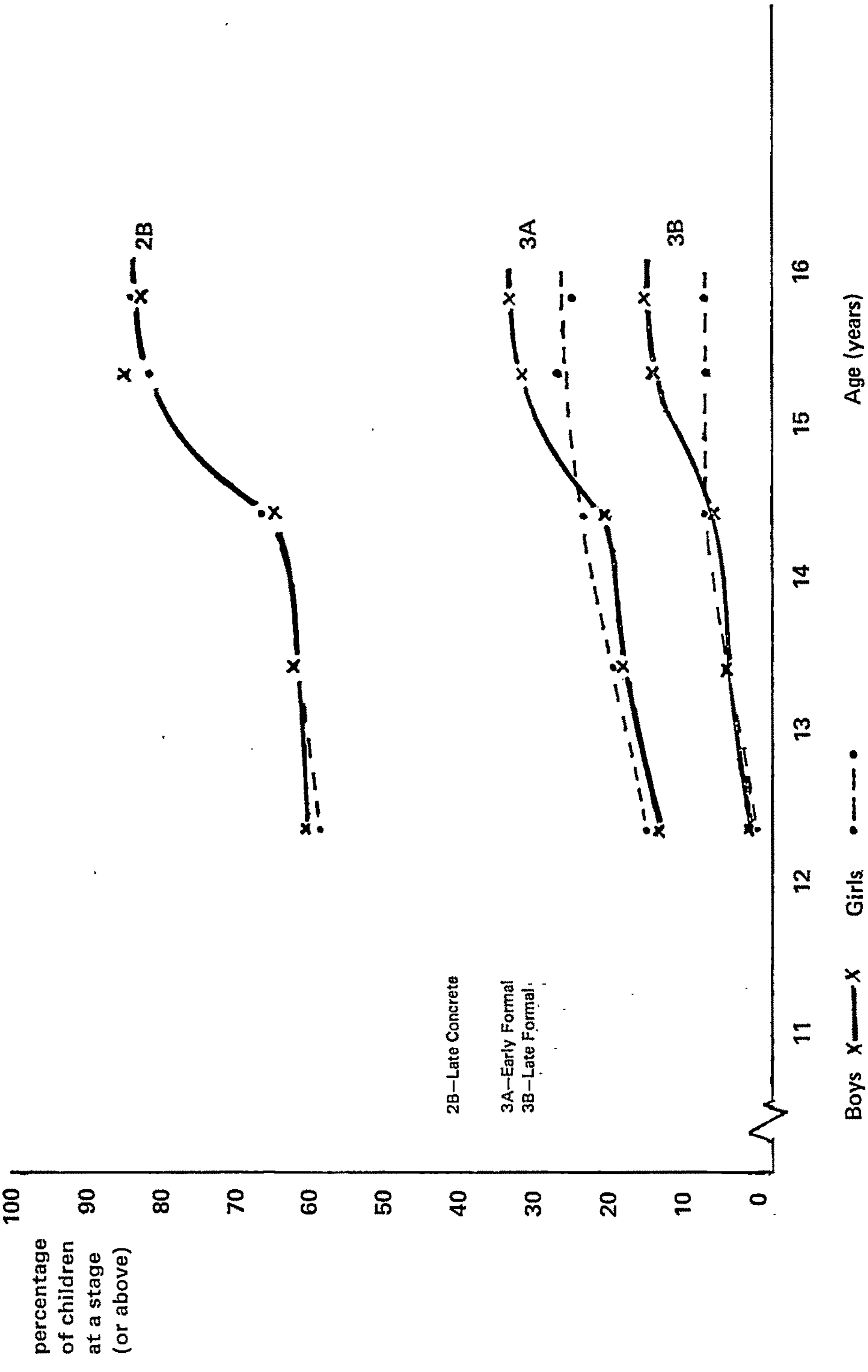


FIGURE 2

TASK II: VOLUME AND DENSITY. BOY/GIRL COMPARISONS

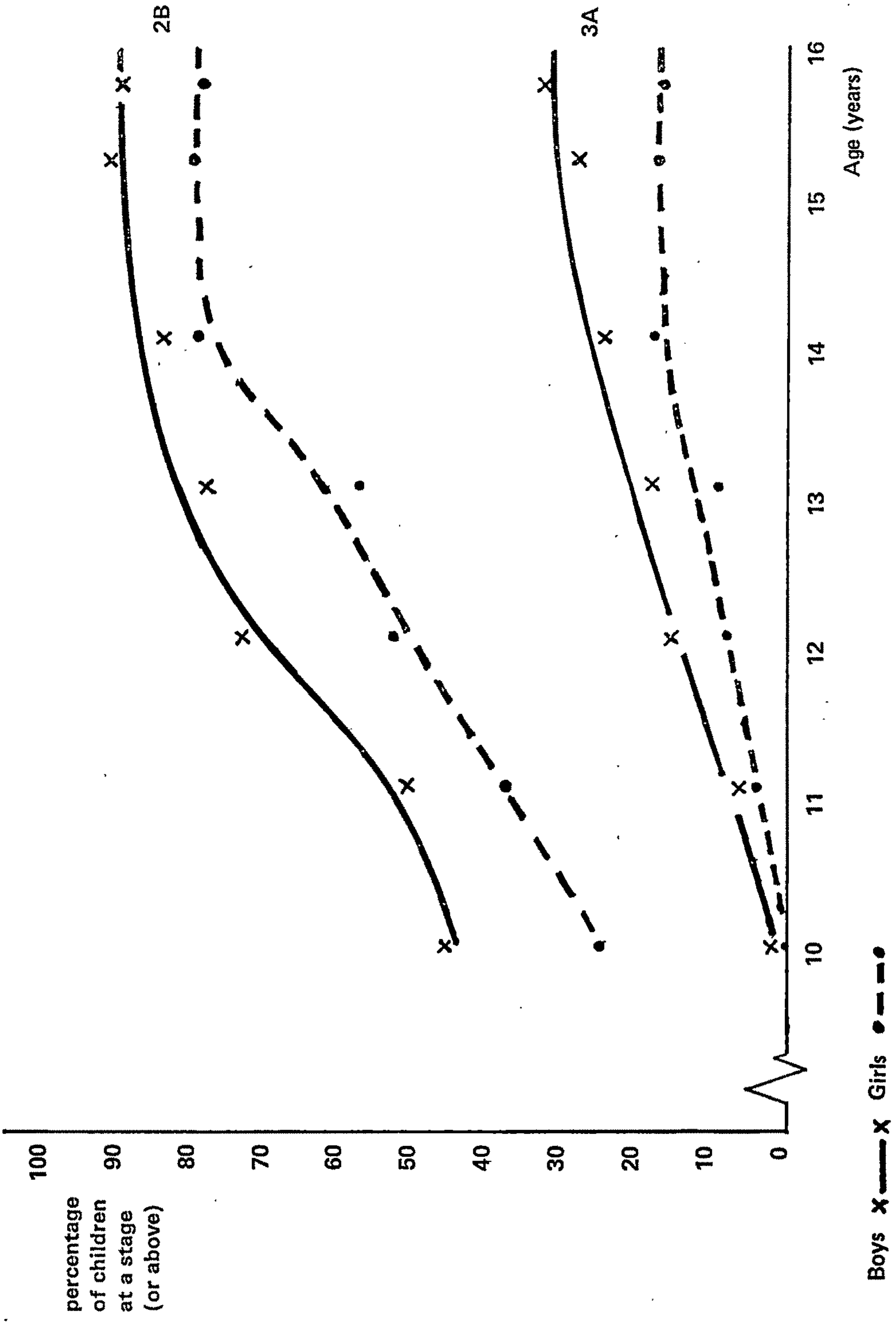


FIGURE 3

PROPORTION OF BOYS AT DIFFERENT PIAGETIAN STAGES AS ASSESSED BY THREE TASKS

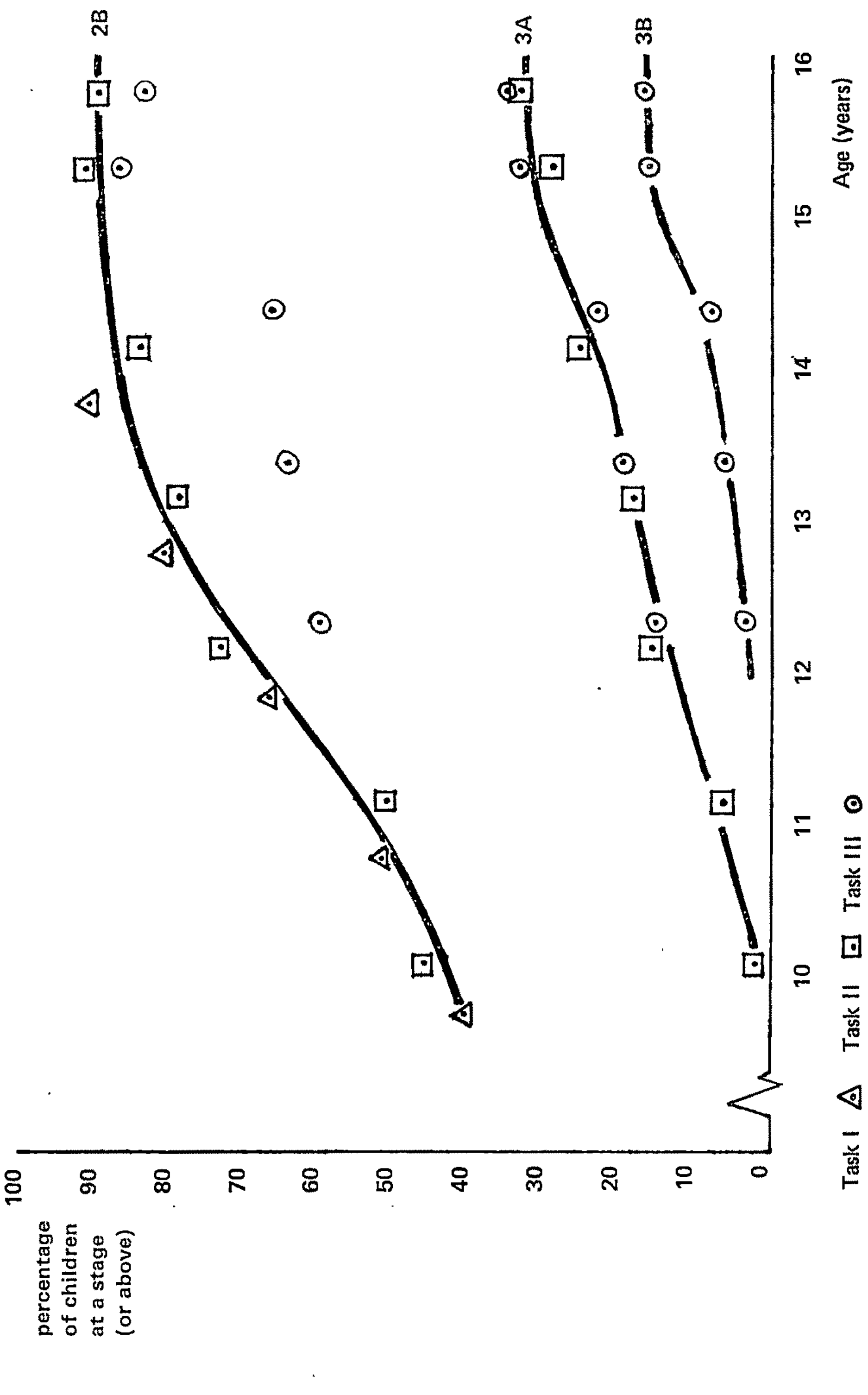
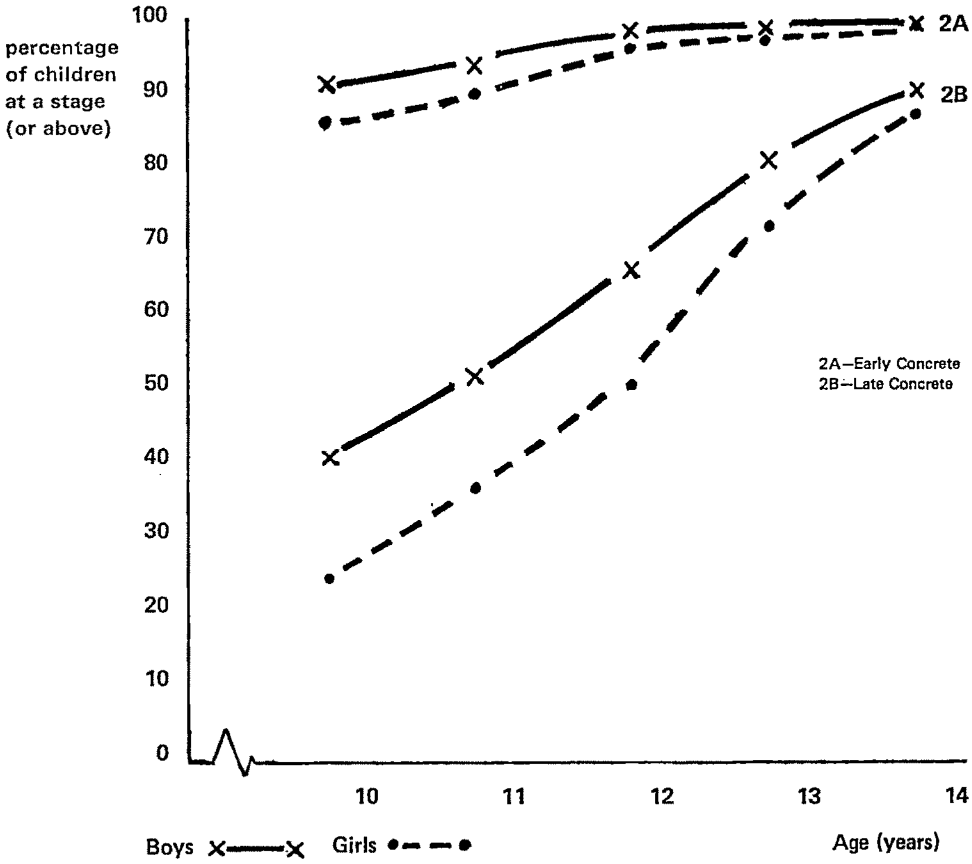


FIGURE 4

TASK I: SPATIAL RELATIONSHIPS. BOY/GIRL COMPARISON



immediate analysis of the problem. In Figure 2 it can be seen that the cessation of development among girls at age 14 parallels that in Task III. From these results it must, of course, remain an open question as to whether there is further intellectual growth, as measured in Piagetian terms, at 17, 18 or later ages. It may be that, even while they are still at school, the performance of some children has begun to deteriorate, while that of others continues to improve. (See Vernon, 1951, in relation to psychometric measures of intelligence.) Thus the population development curve can flatten out, while some children are continuing to develop. That this happens a year earlier for girls than for boys is impossible to interpret without further evidence. It may be that boys get an added boost from their later adolescent growth spurt, or it may be that a greater proportion of girls turn their interest to arts subjects from the third year, and continue to show a development in operational thinking there, which they fail to show on physical science subject matter. Clearly, longitudinal survey evidence would be much more sensitive than cross-sectional in giving evidence on such questions.

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APPENDIX

RELATIONSHIP BETWEEN PERCENTAGE OF BOYS AT 3A LEVEL OR ABOVE ON THE PENDULUM TASK, CALVERT MEAN, AGE AND SCHOOL YEAR

For the fourth- and fifth-year sample, the population of each school was divided into 3-monthly groupings by age. This gave four groupings: beginning at 15:0, 15:3, 15:6 and 15:9. For each age-group the percentage of boys measured at level 3A or above was found; the fourth and fifth year results were kept separate. Boys' results alone were used, as the analysis of sex differentials had already shown that an increase with age, if present, was more likely to be present in their results.

The percentage of boys at 3A or above was then investigated to see how it varied with the Calvert mean for the school, with age and with the school year. To do this a generalised linear model with the logit transformation of the percentage at 3A or above as the dependent variable, the Calvert mean, age and year as the explanatory variables and a binomial error was used (Nelder and Wedderburn, 1972). The results are shown in the table below.

Component	Deviance	Degrees of Freedom	F
Calvert mean	14·70	1	6·89, P 0·05
Age (adjusting for Calvert mean)	0·07	1	0·03
Year (adjusting for Calvert mean and age)	0·38	1	0·18
Residual	66·16	31	
Total	81·31	34	

As can be seen the percentage of boys at 3A or above does vary significantly with the Calvert mean but there is no evidence that it varies with age or school year over the age range investigated.

Acknowledgment—We thank Betty Kirkwood for selecting and carrying out this analysis.

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SCALOGRAM ANALYSIS AND COGNITIVE DEVELOPMENT: EVIDENCE FROM A LONGITUDINAL STUDY

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SUMMARY. A battery of Piagetian-type tasks were administered to a sample of 93 English primary school children four times at six-monthly intervals from an average age of six years as part of a longitudinal study of cognitive development. From a series of scalogram analyses, hierarchies of difficulty were found which were significantly stable from testing to testing in respect of both *items* and *subjects* in the sample.

INTRODUCTION

ONE technique which has been used extensively in the interpretation of data of a dichotomous nature gathered on aspects of cognitive development is that of scalogram analysis. As there are no normative assumptions other than a monotonic relationship between items this method lends itself to the analysis of responses to cognitive tasks where a sequential developmental pattern is postulated. If the analysis reveals a scalable set of tasks this would suggest a hierarchy of difficulty where tasks correctly responded to in scale order presupposes that tasks lower in the hierarchy have been correctly answered. Wohlwill (1960) claims that this ' is equivalent to the assertion of a sequential order of development of the function tapped by these tasks '.

Wallace (1965) has criticised the use of scalogram analysis in cross-sectional research as a substitute for longitudinal evidence on several counts, two of which are the assumptions that with increasing age a change in the direction of a higher scale type should take place and that any given subject, if tested at a prior or later point in time, would still respond in accordance with the scale. He notes that in Wohlwill's opinion this would rest on the adequacy of the sampling and then suggests that a longitudinal follow-up would give a more acceptable proof of validity.

Wallace's criticism of these assumptions can be examined by using data collected as part of a short-term longitudinal study of cognitive development using mainly Piagetian-type tasks.

METHOD

Sample

Ninety-three children (47 boys, 46 girls) from a North London infants' school were given a battery of tasks four times at six-monthly intervals, starting age 6 years. Not all tasks were administered at the second and third testings because of the time factor involved. Sub-groups were also taken of previously untested children at the different age levels to test for practice effects.

Tests

Among pre-tests given were the British version of the English Picture Vocabulary Test (Mean = 106·55; SD 12·05) and Raven's Coloured Progressive Matrices (Mean = 16·62; SD 3·85) and tests to determine the children's understanding of qualitative/relational terms.

The set of Piagetian tasks were selected to cover the major hypothesised groupings together with a number of geometrical tasks. The tasks comprised items involving seriation, one-to-one correspondence, conservation of discontinuous quantity and number, conservation of liquid quantity, solid quantity and weight; conservation of length, measurement of distance, locating a point in two-dimensional space and the Piagetian matrices. (A complete description is available from the author.)

(*a*) *Seriation* (Inhelder and Piaget, 1964). The simple form of ordering a single series of 10 rods, 9 cm to 16·2 cm (difference approx. 0·8 cm) was used (Task A).

(b) *One-to-one correspondence* (Piaget, 1952). This sub-task appeared as part of three tasks. Firstly (Task B) in making another row 'just the same as this one' in the number conservation task and secondly in the two variations on conservation of discontinuous substance (Task C, D).

(c) *Number conservation.* After the equality of the rows was established one row was expanded and a judgment was asked for (Task E). Then two counters (poker-chips) of the original nine in each row were removed and equality re-established. One row was then collapsed (Task F).

(d) *Conservation of discontinuous substance.* Two tasks were administered. The first was the beads and jars test (Piaget, 1952); in this case one-to-one correspondence (Task C) was established between the two sets of 10 beads dropped into identical glass jars by the subject and experimenter. After one set was transferred to another jar of differing dimensions the conservation judgment question was posed (Task G). In the second task one-to-one correspondence was established with matched placing of 13 counters (poker-chips) in two 'towers' (Task D). One 'tower' was then transformed into a cross and the conservation judgment question asked (Task H). Both times the question was of the form "Are there the *same number* of beads/counters. . . . ?"

(e) *Conservation of liquid quantity* (Piaget, 1952). The technique of equalising two amounts of liquid in identical jars with transference, first, to a taller and thinner jar (L1) and, secondly, to four smaller jars was used (L2). A third sub-task was a generalisation task (L3) where the child was shown the standard jar with liquid and an empty wider and taller jar and asked to tell the experimenter to stop pouring liquid when there was the *same amount* in this jar as in the standard jar.

(f) *Solid quantity and weight* (Piaget and Inhelder, 1962). The presentation of these tasks was essentially the same in both cases except for the form of the conservation prediction and judgment questions. Four balls of Plasticine in the ratios of volume 4 : 2 : 2 : 1 were presented and the child asked to choose the two balls having the 'same amount/weight'. A prediction question was then asked: "If I roll this one into a sausage will it *have the same amount* (*Task I*)/*weight* (*Task K*) *the same* as this ball?" Then the ball was rolled and the conservation question posed (Task J, M).

(g) The *geometrical tasks* followed the procedures used by Piaget *et al.* (1960) and Lovell *et al.* (1962). Conservation of length was studied from the length of lines and coincidence of extremities (Task N1) and also change of position using two rods (Task N2). The two other geometrical tasks were measurement of distance (Task P) and locating a point (Task Q).

(h) The set of 9 *matrices* (Task R-Z) as shown in Inhelder and Piaget (1964, pp. 160-161) were used. (It should be noted that in the depicted matrix 8 two of the choice items are incorrectly shown, two of the dogs should be 'spotted' otherwise there is no solution and one choice item appears twice.)

Assessment

The responses of the children were assessed and dichotomous categories for each task or sub-task were prepared, i.e. conservers/non-conservers, correct/incorrect. A conserving response had to be justified by an adequate explanation in tasks outlined in (d), (e) and (f).

RESULTS

Scalogram analyses were prepared using computer programme BMD 05S (Dixon, 1971). It should be noted that the number of subjects in each analysis is 93, which is slightly fewer than the minimum number suggested. In each case the number of items exceeds ten.

Scalogram Analysis 1

Tasks common to all four testings included seriation (Task A), the three number sub-tests (Tasks B, E, F) and the three liquid conservation tasks (Tasks L1, L2, L3) together with the nine Piagetian Matrices (Tasks R-Z). These 16 items were scaled for each testing and the coefficients of reproducibility were respectively 0·88, 0·85, 0·87 and 0·87. The hierarchy of difficulty rankings are shown in Table 1. As can be seen from the table the easiest tasks on the first testing were number, seriation and matrix 1 with liquid conservation tasks appearing near the top of the hierarchy array with the more difficult matrices. The rank order correlations of *items* across all testings were highly significant as were the *subjects*' rank orders (Table 2).

TABLE 1

RANK ORDERS OF SIXTEEN TASKS ACROSS FOUR TESTINGS

		Testing			
	Task	1st	2nd	3rd	4th
			(Rank Orders)		
Z	Matrix 9	16	16	16	16
L2	Liquid: transfer (4 vessels)	15	10	12	11
U	Matrix 4	14	15	14	14
L3	Liquid: generalization	13	14	8	8
Y	Matrix 8	12	13	15	13
W	Matrix 6	11	12	13	15
L1	Liquid: transfer (1 vessel)	10	7	6	6
T	Matrix 3	9	11	10	10
V	Matrix 5	8	6	9	9
X	Matrix 7	7	9	11	12
S	Matrix 2	6	3	3	4
E	Number: expanding row	5	5	4	5
R	Matrix 1	4	8	7	7
F	Number: collapsing row	3	4	5	3
A	Seriation	2	2	2	1
B	Number: 1-1 correspondence	1	1	1	2

TABLE 2

RANK CORRELATIONS ACROSS FOUR TESTINGS
FOR ITEMS AND SUBJECTS

	2	3	4		2	3	4
1	0·89	0·85	0·83	1	0·72	0·65	0·56
2		0·91	0·89	2		0·79	0·76
3			0·97	3			0·82
	(*a*) Items				(*b*) Subjects		

NOTE—For *all* correlations reported P<0·01.

The frequency of particular scale score changes over the four testings show an increase over time in the higher scale patterns. For example, taking the scale level of the first liquid conservation sub-scale (transfer to one vessel) it is found that the percentage frequencies of subjects achieving this task and those above it are 17, 48, 62 and 80 per cent over the four testings. The change in relative difficulty of liquid conservation (transfer to four vessels) and the liquid generalisation sub-task over testings one to three should be noted. The steep drop in relative difficulty of the former task between testings one and two is shadowed by the equally steep drop for the latter task from testings two to three. In terms of frequency of correct responses from first to third testings the change is liquid (transfer), 8, 34, 34 and liquid (generalisation) 11, 23, 44.

Scalogram Analysis 2

Nineteen items from the set of tasks given to all the group at the first and fourth testings were selected. The results of the analysis of the first testing of these items give a scale (Table 3) with a coefficient of reproducibility of 0·89. From an inspection of the 19 Guttman scale scores it was found that 44 per cent of the distribution of scale scores was taken up by the first four scale patterns. Inspection of the matrix of ranked responses indicated that the three tasks involving one-to-one correspondence were the ones passed whereas the other tasks were too difficult. As can be seen in Table 3, the order of difficulty continues with the completion of the conservation of discontinuous quantity tasks, seriation and conservation of length. The other two number sub-tasks are separated by the conservation of weight and one part of conservation of solid quantity. The three liquid sub-tasks and the two geometrical tasks are at the top of the hierarchy. Overall, the response pattern matrix shows that less than 24 per cent of the sample are able to cope with some or all of the other conservation tasks (solid, liquid quantity and weight) at the age of six.

TABLE 3

Difficulty Hierarchies from Scalogram Analysis of Tasks for First and Fourth Testings Showing Number of Subjects (N) Solving Each Task

Hierarchy Level	Testing One			Testing Four		
	Task		N	Task		N
19	Q	Locating a point	1	Q	Locating a point	9
18	P	Meas. of dist.	7	P	Meas. of dist.	41
17	L2	Liq: trans. (4 vess.)	8	L2	Liq: trans. (4 vess.)	45
16	L3	Liq: gen.	11	N2	Length: rods	56
15	L1	Liq: trans. (1 vess.)	16	L3	Liq: gen.	57
14	I	Solid: prediction	28	M	Weight: judgment	60
13	E	Number: exp. row	29	K	Weight: prediction	62
12	M	Weight: judgment	30	I	Solid: prediction	64
11	J	Solid: judgment	30	N1	Length	64
10	K	Weight: prediction	34	J	Solid: judgment	67
9	N1	Length	35	L1	Liq: trans (1 vess.)	70
8	F	Number: coll. row	35	E	Number: exp. row	70
7	N2	Length: rods	35	D	Discon. quant.: 1-1	73
6	A	Seriation	47	G	Discon. quant: cons.	74
5	G	Discon. quant: cons.	51	H	Discon. quant: cons.	74
4	H	Discon. quant: cons.	55	C	Discon. quant: 1-1	76
3	D	Discon. quant: 1-1	71	F	Number: coll. row	78
2	C	Discon. quant: 1-1	76	B	Number: 1-1	87
1	B	Number: 1-1	81	A	Seriation	88

At the fourth testing (age: 7 : 6) the rank order of *tasks* (Table 3) was significantly correlated with that of the first testing (rho = 0·791, P<0·01, df = 17) although there were some changes in ordering.

In the scalogram analysis the number of scale scores were reduced to 16 indicating by this reduction in the number of typical response patterns that there was less variation. The coefficient of reproducibility rose to ·90.

From inspection of the changes observed (Table 3) it is seen that these tend to be grouped within, on one hand, the number-seriation-length cluster and, on the other hand, within the conservation of liquid, solid quantity and weight. The second conservation of length task would appear to be anomalous and although the frequency of correct responses had risen from 35 to 57 over the testing period the proportional increase is less than that on a number of other tasks.

The rank order of subjects from testing one to testing four is also significantly correlated (rho = 0·684, P < 0·01, df = 91).

TABLE 4

FREQUENCY DISTRIBUTIONS OF GUTTMAN SCALE SCORES OF ITEMS SHOWING TYPICAL NEW TASKS ACHIEVED AT SUCCESSIVE SCALE SCORES

	Testing One		Testing Four	
Score	Frequency	Tasks Achieved	Frequency	Tasks Achieved
1	9	None or almost none	1	None or almost none
2	4	1-1 correspondence	2	
3	8		7	Seriation
4	24		2	Number
5	2	Conservation of number: ‘ towers ’ and ‘ beads ’	4	
6	9		1	
7	4	Seriation	2	
8	3	Length	6	
9	2		1	Conservation of liquid (transfer) then conservation in general
10	1		4	
11	1		11	
12	3		2	
13	1		8	
14	7	Solid quantity and Weight	14	
15	6		24	Measurement of distance
16	3	Liquid conservation	4	Locating a point
17	3		—	
18	2	Geometrical tasks	—	
19	1		—	
	93		93	

Table 4 shows the frequency distributions of scale scores at testings one and four indicating the typical new tasks achieved at successive scale scores with numbers of children passing each item. The shift of frequency of successive completion can be seen clearly with the increase in ability to cope with the conservation tasks at the fourth testing. At this fourth testing the cumulative frequency shows that only 4 per cent of the sample were able to complete the full range of tasks. However, if the two most difficult tasks are eliminated then 45 per cent of the sample were able, at this age, to deal with all the other tasks. 27 per cent (25 subjects) were still virtually non-conservers with the majority of these showing a low level of performance overall, at the most dealing with some combination of the first three ranked tasks.

Scalogram Analysis 3

A third scalogram analysis was made to include the Inhelder and Piaget Matrices and to compare the scaling of tasks across testings one and four. Eight of the nine matrices were included (the practice matrix (Task R) was dropped) and a composite classification of conservation of number was used (Task EF). A child was designated a conserver if both parts (expanding and collapsing rows) of the task were passed. The associated one-to-one correspondence response was dropped but the two conservation tasks concerned with discontinuous quantity each contain a one-to-one correspondence response and were retained. The total number of tasks thus scaled was 25. The hierarchies produced by this scalogram analysis are shown in Table 5.

TABLE 5

DIFFICULTY HIERARCHIES FROM SCALOGRAM ANALYSIS OF TASKS FOR FIRST AND FOURTH TESTINGS SHOWING NUMBER OF SUBJECTS (N) SOLVING EACH TASK

Hierarchy Level	Testing One			Testing Four		
	Task		N	Task		N
25	Q	Locating a point	1	Q	Locating a point	9
24	Z	Matrix 9	6	Z	Matrix 9	22
23	P	Meas. of dist.	7	W	Matrix 6	32
22	L2	Liq: trans (4 vess.)	8	U	Matrix 4	36
21	U	Matrix 4	11	Y	Matrix 8	40
20	L3	Liq: gen	11	P	Meas. of dist.	41
19	Y	Matrix 8	14	X	Matrix 7	42
18	W	Matrix 6	15	L2	Liq: trans. (4 vess.)	45
17	L1	Liq: trans. (1 vess.)	16	T	Matrix 3	47
16	T	Matrix 3	20	V	Matrix 5	51
15	V	Matrix 5	21	N2	Length: rods	56
14	X	Matrix 7	25	L3	Liq: gen	57
13	EF	Composite Number	27	M	Weight: judgment	60
12	I	Solid: prediction	28	K	Weight: prediction	62
11	S	Matrix 2	29	I	Solid: prediction	64
10	M	Weight: judgment	30	N1	Length	64
9	J	Solid: judgment	30	EF	Composite number	65
8	K	Weight: prediction	34	J	Solid: judgment	67
7	N2	Length: rods	35	L1	Liq: trans (1 vess.)	70
6	N1	Length:	35	S	Matrix 2	71
5	A	Seriation	47	D	Discon. quant. 1-1	73
4	G	Discon. quant: cons.	51	G	Discon. quant: cons.	74
3	H	Discon. quant: cons.	55	H	Discon. quant: cons.	74
2	D	Discon. quant: 1-1	71	C	Discon. quant: 1-1	76
1	C	Discon. quant: 1-1	76	A	Seriation	88

The ranking of the tasks from this second analysis of the first testing shows the matrices above the judgments of solid quantity and weight and mainly interwoven with the sub-tasks of liquid quantity. This clustering of the matrices with the conservation tasks suggests that they are not likely to be solved successfully by children of 6 years. The coefficient of reproducibility has fallen to 0·88 giving an indication of the possibility of sub-scales. At the fourth testing the coefficient of reproducibility is 0·87 indicating a slightly greater variability within scale score patterns from testing one although there is one less scale score rank. The frequency distributions of Guttman scale scores of the 25 items (Table 6) show the typical patterning of new tasks achieved.

The rank order of both subjects and items at the fourth testing for this analysis are highly correlated with the orders at the first testing. For *subjects*, rho = 0·691, $P < 0{\cdot}01$, df = 91 and for *items*, rho = 0·849, $P < 0{\cdot}01$, df = 23.

TABLE 6

FREQUENCY DISTRIBUTION OF GUTTMAN SCALE SCORES OF ITEMS SHOWING TYPICAL NEW TASKS ACHIEVED AT SUCCESSIVE SCALE SCORES

	Testing One		Testing Four	
Score	Frequency	Tasks Achieved	Frequency	Tasks Achieved
1	9	None or almost none	4	None or almost none
2	7		6	Seriation
3	19	1-1 correspondence	1	Discon. Quant, : 1-1 and conservation
4	5	Discon. Quant. Conservation	2	
5	9	Seriation	5	
6	12		2	
7	2		6	Liquid transfer and Solid (judgment)
8	2		1	
9	3		2	
10	3	Conservation of length, quantity and weight	3	Composite number
11	6		6	Conservation of length
12	1		1	Weight and Liquid (generalization)
13	3	Composite number	4	
14	3		11	Liquid (4 vessels)
15	1		5	Matrix 5
16	1		3	
17	1	Matrices 7, 5, 3	3	Matrix 3
18	1		2	Matrix 7 and Measurement of distance
19	1	Conservation of liquid	2	
20	2		2	
21	1	Matrix 9 and geometrical tasks	12	Matrices 8, 4, 6
22	1		6	Matrix 9
23	—		4	Locating a point
	93		93	

DISCUSSION

The three sets of scalogram analyses show that the tasks are not fully scalable at each testing if the coefficients of reproducibility are considered. However, the analyses do give orders of difficulty which support, in general, the findings of Piaget and others. For example, the seriation and number tasks are dealt with successfully more often and appear lowest in the hierarchy. The position of conservation of discontinuous substance (number) supports Elkind's (1961) rather than Feigenbaum's (1963) findings. Also, the scaling of conservation of discontinuous substance before conservation of length as noted by Siegelman and Block (1969) is also found in this study. The conservation of solid and weight at the first and fourth testings with respect to the judgment responses would seem to comply with the hierarchy of difficulty found by others and predicted by Piaget in terms of horizontal décalage. However, the prediction responses at the first testing are inverted, that is, the prediction of ' same amount ' of solid quantity being higher in the hierarchy.

The two geometrical tasks which appear at the top of the hierarchies in analyses one and two were consistently the most difficult even though there was evidence from work done in the schools that, at least, notions of unit measurement had been taught to the children. The difficulty of these two tasks is in accordance with the findings of Lovell *et al.* (1962) who found that chlidren of 6 to 7 are unlikely to have success with them.

Brainerd (1973) notes that the developmental relationships between seriation and other concrete-operational skills should be examined. Here one finds that seriation, as measured by Task A, comes low in the hierarchy of difficulty at age 6 and is the easiest task at age 7 years 6 months.

One problem of longitudinal research is the possible effect of repeated measurements especially in tasks which are likely to have a high learning component. However, from the evidence of comparing previously untested sub-samples drawn at each successive age point, the problem would not seem to manifest itself greatly. There was no significant difference in the number of non-conservers across the sub-samples and the longitudinal sample. There were differences, however, in some task areas in the proportions of children in the sub-stages of partial conservation and full conservation with a higher proportion of children in the longitudinal sample having full conservation.

The findings of the three sets of scalogram analyses give evidence which support the use of scaling techniques, however, with some caution, in cognitive developmental research. In general, Wallace's (1965) two criticisms are found to be not valid from the evidence of both the rank ordering of items and of subjects in this sample across the testings. Individual variation occurs but the general pattern remains.

Further work remains to be done on individual children's response patterns and the analysis of latent structure.

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RESEARCH NOTES

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DOES HOW YOU LEARN MATHS INFLUENCE HOW YOU FORM CONCEPTS?

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SUMMARY. The performance of children who had experienced Dienes and Fletcher mathematics schemes was examined on abstract and real-life concept-formation tasks (N=16 per group). No overall difference was found between children taught mathematics under the different schemes, but those taught by the Dienes method formed real-life concepts more successfully.

INTRODUCTION

Attention is currently being focused upon innovations in the teaching of mathematics. Most of these, particularly at the primary stages of education, tend to be linked with the idea of ' learning by discovery '. ' Activity ' and ' discovery ' methods of teaching, as propounded by Bruner (1961), became popular in British primary schools following publication of the Plowden Report (1967), but the efficacy of ' discovery ' has proved difficult to evaluate experimentally. On the one hand, most ' discovery ' methods, in their entirety, are too all-embracing to be amenable to experimental examination (Shulman and Keislar, 1966). On the other hand, the constituent parts of such methods, when each is considered in isolation, may well comprise too small a proportion of a child's total experience to produce any measurable effect. The best strategy seems to be to follow Bruner's (1966) recommendation to " look for treatments that are worth the trouble of investigation ", and Wittrock's (1966) observation that learners' proactive influences will be far more influential than any brief experimental treatment, by contrasting the attainment of children who have been exposed, for some time, to different teaching methods that are both widely used. Our experiment compares the effectiveness in fostering the development of concept formation skills, of exposure for periods ranging from three to six years to two different methods of teaching mathematics to primary school children, one method (Dienes) of the general ' discovery ' type, the other (Fletcher) of the ' expository ' kind.

Dienes (e.g., 1965) explicitly sees his ' dynamic search activity ' method of mathematics teaching, as aiming towards the development of skills for the formation and manipulation of concepts, particularly abstract concepts. However, he contends that these skills are learned best through the child's direct involvement with concrete objects. In his system these objects are wooden and plastic blocks of various sizes and shapes which are designed to lead the child towards an understanding of both arithmetical and logical operations of varying degrees of complexity.

This can usefully be contrasted with a method of teaching using a series of text-books such as Fletcher (1970), where, despite the difference in teaching approach, the expressed goals of the teaching are very similar. In Fletcher, as in Dienes, the aim is to develop basic understandings and cognitive abilities rather than simply standard arithmetical skills.

The experimental task selected was a concept formation one, similar to that of Conant and Trabasso (1964), adapted from Bruner, *et al.* (1956). Such a task, which requires subjects to identify conjunctive concepts relating familiar geometrical shapes, ought to be a method of evaluation acceptable to proponents of both teaching methods, for it involves the fundamental psychological skills of classification, abstraction and rule-induction. If one method is ' more effective ' than the other, it ought at least to be more effective in furthering these skills.

The experiment was designed to test five hypotheses, three main ones and two subsidiary. The first is that children who have learned maths *via* Dienes' method should perform better on the concept formation task than the other children. This is a direct investigation of Dienes' claims.

The second hypothesis is that the longer children have been exposed to Dienes' materials, the greater the differential should be. It is a natural corollary of Dienes' claims that the more experience children have had with his method the better developed their understanding and abilities will be, compared with other children.

The third hypothesis is that the differential between Dienes and Fletcher children should be greater for 'real-life' than for 'abstract' stimuli; for while the latter children have had experience only with abstract, symbolic material, the former's concrete experience should pay off particularly when they are confronted with a concept involving concrete, familiar, real-life objects.

The fourth hypothesis is that girls should perform better than boys. In the literature there is much controversy about sex differences in cognitive skills, but Dienes himself (1959) has claimed to find differences between 11-year-old girls and boys, whilst Tagatz (1967) reports that 11- and 12-year-old girls are superior to boys in concept formation.

The fifth hypothesis we tested was that there would be a positive correlation between intelligence and performance on the task. Mathematical and logical reasoning form major components of IQ tests, so there should be a significant relationship in this experiment. Vinacke (1974), for example, includes intelligence in his list of factors that influence children's concept attainment.

METHOD

Schools

Although the Dienes and Fletcher methods appear very different, in practice they may not be. Some teachers using the Fletcher text-books, for example, may supplement them with the use of concrete Dienes-type materials and exercises. It is therefore necessary to say something about how the two schools implemented the schemes. While it is obviously impossible to achieve a *pure* contrast between expository and discovery methods, we hope these details will make it clear that we have achieved a *strong* contrast.

The Fletcher school adhered rigidly to the Fletcher series of books, each child progressing through them individually at his or her own pace. The series comprises a set of work books, containing abstract pencil and paper exercises that the children complete themselves. Much of the text is in the form of diagrams and pictures, and except for one book in the first series which deals with solid shapes such as cones and cubes, solid objects are not used at all. No Dienes or Dienes-like materials were available in this school.

The Dienes school arranged the whole of its mathematics teaching around the use of Dienes material. The precise method used was originally worked out by the teachers themselves before the school opened in 1965, and has been slightly modified over the years. All the maths teachers of long-standing in the school have attended special courses in the use of these materials at Reading University, and students from Reading often visit the school to see the Dienes method in action. Each class has a large stock of Dienes blocks. The blocks are used by the children in conjunction with work-books of the teachers' own devising and manufacture. The blocks are used constantly throughout the first four years.

Apart from their different approaches to mathematics, the two schools were similar in social composition and educational style. They occupied similar positions on opposite sides of an industrial town and served large, post-war council estates. Both operated the 'integrated day'.

Subjects

In each school, two equivalent second year (8-9 years old) and fourth year (10-11 years old) groups were selected, of 16 pupils each (8 boys and 8 girls), matched for IQ and socio-economic status. One group within each year was designated the *Abstract* group, and the other the *Real-life* group.

In the Dienes school six classes were drawn from four second year classes and two fourth year classes. In the Fletcher school, which was larger, six second year and six fourth year classes formed the pools from which selections were made. In order to allow for differences between the styles and personalities of different teachers the children were distributed equally between the four experimental groups so that each group had a similar mix of children from the various teachers' classes.

Time-dependent variations in situation and temperament were controlled by visiting the two schools alternately, and by matching across groups for day of the week and time of day that testing took place.

All children were tested individually in a small room.

Materials

Two sets of 16 cards were prepared, each containing pictures of *either* two geometrical shapes (circle and triangle) *or* two common objects (cup and spoon). The former set are the *abstract* stimuli, and the latter the *real life*. Each set contained all possible combinations of large and small, and black and white stimuli; so for example the real life-set contained a card with a large, black cup and a large black spoon, another with a large white cup and a small black spoon, and so on.

Procedure

Each child was first put at his ease and allowed to play with the set of cards (either real-life or abstract, depending on which group he was in). He was asked to pick out all the cards with a *black* triangle (cup), then with a *white* triangle (cup), then with a *small* triangle (cup), then with a *large* triangle, (cup), and then likewise with the circles (spoons). Each time his attention was drawn to the fact that exactly half the cards possessed the relevant feature, to get him introduced to the logic of the set. Following this he was asked to pick out all the cards possessing a pair of specified features, such as *large* triangles and *black* circles, of which there were four. The experimenter then produced two cards labelled " Yes " and " No ", and said " Now we are going to play a game. In this game there will be four of one kind of card and 12 of the other. Under ' Yes ' I shall put one of the kind of cards I am thinking about. Now you give me the other cards one by one. If it is the kind of card I am thinking about, I shall put it under ' Yes '. If it is not the kind of card I am thinking about, I shall put it under ' No '. Your job is to try and find out what kind of card I am thinking of." They played one practice game, and then four ' serious ' ones. Their performance was measured in terms of the number of cards selected before they either had all the " Yes " cards or verbalised the concept. After the fourth problem, the children were asked " How did you do it? " and their replies recorded.

Each child was given one problem of each of four types: colour-colour (CC e.g. *black* triangle and *white* circle), size-size (SS e.g. *large* triangle and *large* circle), size-colour (SC e..g *small* triangle and *white* circle), and colour-size (CS e.g. *black* triangle and *small* circle). One child in each group received each of the 16 possible orders of the four problem types.

RESULTS

Table 1 shows the mean total number of cards required to solve the four problems for each group. A four-way analysis of variance, with Schools (Dienes *vs.* Non-Dienes), Age (8–9 years *vs.* 10–11 years), Concept (abstract *vs.* real-life) and Sex (boys *vs.* girls) showed a significant effect of Age, F(1,117) = 34·2; P < ·001, and a significant School × Concept interaction, F(1,122) = 5·02; P < ·05. There was no significant improvement in performance over the four problems.

TABLE 1

MEAN NUMBER OF CARDS NEEDED TO SOLVE FOUR PROBLEMS IN EACH CONDITION

Age groups	Dienes		Non-Dienes	
	Abstract concepts	Real-life concepts	Abstract concepts	Real-life concepts
8-9 years	31·06	26·69	30·44	30·13
10-11 years	25·00	21·19	19·56	23·06
Mean	28·03	23·94	25·00	26·59

There is a significant effect of problem type (CC, SS, CS or SC), $F(1,500)=22{\cdot}54$; $P<{\cdot}001$. This is due to the fact that the same-dimension problems (CC and SS) are much easier than the different-dimension problems (CS and SC). The mean number of trials to solution are 5·41 and 7·54. However the School × Concept interaction remains significant for both kinds of problem when analysed separately.

There is virtually no correlation between performance in this experiment and IQ (measured by the NFER non-verbal B.D. test (Pidgeon, 1965). The Pearson product moment correlation coefficient for the Dienes school is 0·16 and for the Non-Dienes school 0·06.

DISCUSSION

The results show quite clearly that, when examined under controlled conditions, Dienes' claims for the advantages of ' dynamic search activity ' in learning mathematics are not supported. There was no overall superiority of the Dienes school (hypothesis 1). And there was no relative improvement of Dienes children with age (hypothesis 2).

However the Dienes and Fletcher children *did* differ in reaction to the abstract and the real-life stimuli: for Dienes children, concepts that involve pictures of real objects are more easily attained than those involving geometrical shapes; while for Fletcher children there is no difference. Thus exposure to the Dienes material may have had an effect on children's ability to operate with different types of picture even though it did not appear to produce an overall improvement in concept formation performance when compared to more traditional teaching methods.

The fact that the Dienes children perform better with the pictures of familiar, three-dimensional objects suggests that their handling of concrete shapes in the context of their mathematical education may have enabled them to generalise the relevant reasoning skills to out-of-school situations. Both groups of children will be very familiar with two-dimensional circles, triangles etc., such as those used in this experiment for the abstract stimuli, so with stimuli like these there is no reason to expect a superiority of the Dienes method. (In fact the experiment shows that the Dienes children are actually slightly inferior to the Fletcher children with these shapes: perhaps the more concentration paid to such shapes in the latter method could account for this.) But we might argue that the Fletcher children's skills for the deduction of logical concepts have been exercised and developed predominantly in the context of these kinds of diagram, while for the Dienes children the range of stimuli that have come to ' call ' these skills (see Claxton, 1977) has been developed more widely. The study may therefore be interpreted as pointing towards a *slight* superiority of the Dienes over the Fletcher method, in that the children seem to be able to apply the results of learning to a somewhat wider range of stimuli.

It is perhaps worth pointing out that this result demonstrates that the experimental task is not insensitive to differences between manipulations and between subjects. If there were any substantial differences between the two teaching methods, therefore, it is plausible to suppose that they would have been picked up in the present experiment.

The failure to detect any sex differences in this study conflicts with Dienes' results, but is in line with the majority of research. Klausmeier *et al.* (1964), Shields *et al.* (1969) and Furth *et al.* (1970) all failed to find sex differences between children of similar age to those tested here on concept formation tasks.

The very low correlations between performance in this task and IQ are initially surprising, but again there are some previous studies which add support to this finding. Saltz and Hamilton (1969) found no difference, with 8-year-old children, in mean errors in a concept learning task as a function of IQ. Corder and Corder (1974) found no significant relationship between WAIS scores and concept learning with college students. And Odom (1974), using 6-, 9- and 11-year-old children again failed to find IQ effects. It appears that the kind of ability being tapped in a concept formation task, which is very non-verbal, is different from that which contributes to IQ performance. Corder and Corder's (1974) evidence suggests that ' cognitive flexibility ' (as measured by the Alternative Uses Test) is more important in concept formation than ' intelligence '.

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SPELLING ACCURACY AS A FUNCTION OF REPRESSION-SENSITIZATION

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SUMMARY. Whether an individual's spelling accuracy is related to personality apart from general intellectual capacity was investigated by giving a spelling test to 80 undergraduates, 40 repressers and 40 sensitizers identified on the basis of scores received on Byrne's Repression-Sensitization Scale. The sensitizers were clearly superior to the repressers in their spelling accuracy, and this difference was not an artefact of differences in intellectual aptitude as determined by SAT verbal and quantitative scores. In fact, among the male subjects the repressers, with lower spelling scores, had higher quantitative SAT scores than sensitizers.

The present study undertook to discover if the ability to spell accurately is related to the personality dimension, repression-sensitization. Sensitizers are 'obsessive-compulsive' individuals who intellectualise and attempt to control stimuli and situations which for them are anxiety-arousing. Repressers are impulsive individuals who avoid anxiety-arousing stimuli and utilise denial and rationalisation (Byrne, 1964). It was expected that sensitizers would be superior to repressers in spelling accuracy.

The subjects were 350 undergraduates enrolled in psychology courses. Byrne's (1961) Repression-Sensitization Scale, consisting of 156 items from the MMPI, was administered to these subjects during their regular class meetings. The scoring criterion for identifying repressers and sensitizers was such that one point was gained for each response in the keyed (sensitization) direction, and low scores (0-52) were defined as indicative of repression and high scores (78-156) as indicative of sensitization. From the total pool of subjects, 43 repressers and 48 sensitizers were so identified.

To these 91 subjects a spelling test was subsequently administered which was taken from a handbook of English grammar, *Harbrace College Handbook*, and which consists of the 100 words most frequently misspelled as determined by a large sampling of the written work of college students (Hodges, 1962). The test was administered in group settings, and the words were dictated at the approximate rate of one word every 10 seconds. When a word was a homonym, a sentence was also provided to clarify which meaning was intended, e.g., " Their car is red." " There it is." A subject's spelling score consisted simply of the number of words spelled correctly.

Scholastic Aptitude Test (SAT) verbal and quantitative scores were employed as an index of intellectual ability to check the possibility that any differences in the spelling scores of the repressers and sensitizers were confounded with a difference in intellectual ability of the two groups. No SAT scores were available for six sensitizers and three repressers, and these subjects were eliminated; the two sensitizers with the lowest repression-sensitization scores also were excluded in order to have groups of equal number. Thus, in the final sample, there were 40 repressers (17 males, 23 females) and 40 sensitizers (15 males, 25 females) whose repression-sensitization scores ranged from 27 to 52 and from 80 to 115, respectively.

Since sex differences were apparent in the data after they had been collected, sex was included as a factor in all analyses. The spelling scores, which are shown in Table 1, indicate (1) that the sensitizers were clearly superior to the repressers and (2) that the females scored higher than the males. A factorial analysis of variance performed on the spelling scores confirmed the statistical significance of these observations, $F(1,76)=7{\cdot}12$, $P<{\cdot}01$, and $F(1,76)=5{\cdot}32$, $P<{\cdot}02$, respectively, and the analysis indicated no interaction between sex and repression-sensitization, $F<1{\cdot}0$.

The Verbal and Quantitative SAT scores are also shown in Table 1. For the verbal scores, the repressers and sensitizers were nearly equivalent, and although the males' scores were higher than the females', none of the F-ratios from the analysis of variance approached statistical significance. Mean quantitative SAT scores, on the other hand, were higher for the

TABLE 1

Means and Standard Deviations of Spelling and SAT as a Function of Repression-Sensitization and Sex

Group	Sex	N	Spelling		SAT verbal		SAT quantitative	
			Mean	(SD)	Mean	(SD)	Mean	(SD)
Repressers	Male	17	71·9	(19·9)	455·5	(84·4)	480·9	(82·1)
	Female	23	79·0	(11·5)	410·3	(77·0)	411·7	(60·6)
	Total	40	76·0	(15·8)	429·5	(82·4)	441·1	(77·7)
Sensitizers	Male	15	80·0	(12·9)	425·7	(67·3)	418·1	(44·6)
	Female	25	87·0	(9·0)	421·0	(83·3)	425·2	(80·9)
	Total	40	84·4	(11·0)	422·8	(76·8)	422·5	(69·0)
Combined sample	Male	32	75·7	(17·2)	441·5	(77·2)	451·5	(73·4)
	Female	48	83·2	(10·9)	415·9	(79·7)	418·7	(71·5)
	Total	80	80·2	(14·2)	426·2	(79·2)	431·8	(73·6)

repressers, and this difference was produced by the superiority of the male subjects. Analysis of variance indicated a significant interaction of sex with repression-sensitization, $F(1,76) = 5{\cdot}65$, $P < {\cdot}02$, as well as a main effect for sex, $F(1,76) = 3{\cdot}96$, $P < {\cdot}05$.

The present results thus support the hypothesis that sensitizers are on the average better spellers than repressers. The obtained difference was large, and it was not an artefact of greater intellectual capacity, as measured by verbal and quantitative SAT scores, of the sensitizers. In fact, the mean quantitative SAT scores for the males quite clearly favoured the repressers. On this basis, it seems that males who are better in mathematics are worse in spelling.

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RELATIONSHIPS BETWEEN LEARNING STRATEGY, ATTENTION DEPLOYMENT AND PERSONALITY

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SUMMARY—The work reported involved detailed study of 14 students learning a large and complex body of subject matter. A specific aspect of learning strategy (the extent to which students developed their understanding on a broad or narrow front) was examined. In general the results support hypotheses predicting positive relationships between a broad strategy in learning, wide attention deployment, a flexible approach to problem-solving and cognitive complexity. The relationships of measures of intelligence, extraversion and neuroticism, to the above factors were also examined.

INTRODUCTION

Broadbent's original (1958) filter theory of attention advocating a serial mode of information processing was modified by Treisman (1960, 1964, 1969) to accommodate evidence that 'unattended' signals were not blocked completely. Since that time many authors (e.g. Kahneman, 1973; Schneider and Shiffrin, 1977) have discussed parallel processing and the capacity of humans to do or to think about more than one thing at once and to vary width of attention.

Width of attention can vary from being highly selective and focused on a specific task (Easterbrook, 1959) to the other extreme when, during REM sleep, attention appears to be at its least selective and stimuli applied during or before sleep will elicit complex imagery and associations (Fiss *et al*, 1966). A number of investigations have examined individual differences in width of attention—work attempting to relate differences in attention deployment to creativity (Mendelsohn and Griswold, 1964, 1966; Laughlin, 1967; Laughlin *et al*, 1968). Although any person's width of attention will vary from time to time (depending on arousal for instance) there may be stable individual differences in modes of attention deployment. For example, some people may tend to operate with consistently narrower attention than others. Operationally this means that they would be relatively insensitive to the influence of peripheral information sources. A person displaying wide attention would process and be more likely to be influenced by peripheral cues as well as those of immediate relevance to the current mental set or focus of attention.

Such differences in width of attention may be placed in the context of more general theories of cognition. Many current theories have something in common with the formulation suggested by Miller *et al*, (1960) who introduced the notion of TOTE units as subprocesses or operations which may be organised into sequences of goal-directed activity. Others, e.g. Pascual-Leone and Smith in Case (1974) and Shallice (1972) concern themselves with related ideas such as schemes or action systems.

As several workers have shown (e.g., Allport *et al*, 1972) subjects have been able to divide attention in a manner that it is not consistent with a single channel hypothesis and in the theories quoted above humans are seen as functioning through the operation of processes that operate serially or concurrently. In effect, differences in width of attention can be seen as differences in the amount of parallel processing taking place and in the extent to which action systems or procedures are operating concurrently. People differing on a dimension of this type would be expected to exhibit differences in their learning activities.

Pask and Scott (1972, 1973), Pask (1976b) have shown that learners exhibit some consistencies when selecting routes through a large body of subject matter and have distinguished between serialists and holists. Serialist learners tend to progress on a localised, step by step basis whereas holists progress in a more global fashion assimilating information on a wider range of topics. A non-technical discussion of these ideas is provided by Daniel (1975).

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In the study reported here interest is centered on the demonstration by Pask and others (e.g. Bruner *et al*, 1955; Newell and Simon, 1965) that in general terms, some people conduct their learning or problem-solving activity in a controlled, localised fashion and introduce minimal complexity or breadth. Conversely there are learners whose activity, from an external observer's point of view, appears less orderly and less predictable and who appear to extend their understanding in a more global fashion by investigating several areas more or less simultaneously.

In earlier issues of this journal Pask (1976a, 1976b) has described a teaching system—INTUITION—that can be used to observe learning strategies adopted by students. The study described below examined the progress of a group of students on INTUITION and tested various hypotheses, relating differences in learning strategy to attention deployment and other factors.

METHOD

Sample

The sample consisted of 14 GCE A-level students (9 male, 5 female, at an English grammar school). The students used the INTUITION equipment to learn about probability theory. They worked on the equipment individually for sessions of 1½-2 hours once or twice a week. The material was divided into 3 modules with a total learning time of 18-26 hours. 14 students completed Module One and 10 completed Module Two.

Apparatus

When learning about probability theory on INTUITION the student is presented with a body of subject matter clearly divided into three categories or universes of discourse. One category ' Real ' is concerned with actual activities in the real world, such as throwing dice. Another category ' Abstract ' is concerned with the representation of these real activities in abstract terms, such as using a probability number derived from observed long-run stable frequencies. The third category ' Analogical ' concerns the analogical relations that obtain between the two other categories; so that for example, a list of (real) simple results is related analogically, via a theory of simple experiments to an (abstract) event set of simple events. The apparatus demands that students reach a deep level of understanding of each topic attempted in working towards the aim topic, which ensures that, in the end at least, connections are made between the real world and the abstract representation. As they work through the material students choose their own route (within the constraints of the system) through the topics that make up the subject matter. There is no single pre-determined route to follow.

Records obtained show large and consistent differences in routes taken by students. The differences are most clear when the extent to which students adopt a narrow or broad strategy are examined. A student displaying a narrow strategy would begin work on a particular category (e.g., Real) and confine his activity to this area until all relevant topics were understood. Then he would move on to a new area. By contrast a broad strategy is shown by a student who begins work on a second or third category before he has completed all the topics in his first choice. It should be noted that for this distinction to be made it is irrelevant which areas a student learns first; the narrow/broad classification relates only to the extent to which a student advances on a broad front or a narrow one. However, for other purposes, the choice of ' real world ' or ' abstract ' routes by learners following a narrow front could be an interesting difference, but one that was not included in the present study.

As Pask (1976b) has noted the holist/serialist distinction concerns learning *strategy* and appears to be an extreme manifestation of more fundamental differences related to learning *style* (the precise form of the strategy exhibited will depend on the apparatus/method used to observe learning patterns). The distinction between narrow/broad learning is similar in many ways to the holist/serialist distinction. One specific difference between the categories narrow/broad and holist/serialist is that the choice of ' aim ' topic is unimportant for the narrow/broad distinction, whereas it is used in deciding holist/serialist classification. Both strategies, however, concern the extent to which learners progress through material in a controlled, localised fashion or on a more global basis and it is possible that they are both linked to the same more fundamental processes. The theoretical ideas and data presented in the current study make tentative links between the narrow/broad distinction and underlying differences in attention deployment.

Test Materials

The students were given the following tests:

(1) A test of width of attention designed to examine the extent to which students used peripherally or centrally presented cues in a problem-solving situation. (Based on Mendelsohn and Griswold, 1966).
(2) The Bieri (1966) test of cognitive complexity to assess the extent to which students construed other people in a multi-dimensional, or more nearly uni-dimensional fashion.
(3) A problem-solving test designed specifically for this study. The test enabled the experimenter to observe the degree of persistence (i.e., tendency *not* to change from a possible solution route) or flexibility (i.e., tendency to shift from one route to another) shown by students.
(4) The Gergen-Morse (1967) test of self-consistency designed to assess the extent to which people see their own characteristics as compatible or as incompatible and contradictory.
(5) The AH5 test of general intelligence (Heim, 1968).
(6) The Eysenck Personality Inventory (Eysenck and Eysenck, 1964).

Further details of all tests and other ideas discussed in this article are given in Robertson (1976).

On the basis of their learning records, students were classified as adopting a narrow or broad strategy for each module. The students with a narrow focus made virtually no use of analogies except towards the top of the entailment structure. It was thus possible to distinguish the two groups of students by their strategies, and differences between the groups were examined. Of the 14 students who completed the first module 6 worked sequentially through a single category while 8 adopted a broader strategy. For module 2, 5 students adopted a narrow strategy while 5 exhibited the broader strategy. (The consistency of students' strategy over the two modules was high—a correlation of 0.85 between modules 1 and 2).

Hypotheses were tested concerning relationships between the narrow/broad distinction and other variables. The hypotheses anticipated positive relationships between a broad learning strategy and:

(i) wide attention deployment;
(ii) high cognitive complexity;
(iii) low persistence during problem-solving;
(iv) low self-consistency.

No directional hypotheses were possible in relation to scores on the AH4 or the EPI.

TABLE 1

DIFFERENCES IN MEAN SCORES BETWEEN STUDENTS USING NARROW OR BROAD LEARNING STRATEGIES

Test		Module 1				Module 2			
		Narrow (N=6)	Broad (N=8)	t	P<	Narrow (N=5)	Broad (N=5)	t	P<
Breadth of Attention Deployment	Mean	0·69	1·15	2·29	·05	0·64	1·23	2·16	·05
	(SD)	(0·09)	(0·51)	**		(0·11)	(0·54)	**	
Cognitive Simplicity*	Mean	136	123	0·99	NS	151	107	2·84	·025
	(SD)	(18·8)	(29·5)			(26·7)	(14·7)		
Persistence in Problem-solving	Mean	11·50	7·13	2·62	·025	11·40	6·00	2·86	·025
	(SD)	(3·10)	(2·67)			(3·38)	(1·67)		
Self-consistency	Mean	42·7	37·6	0·54	NS	38·8	44·8	0·59	NS
	(SD)	(17·4)	(14·7)			(18·70)	(8·38)		
Extraversion	Mean	13·8	14·9	0·30	NS	14·2	15·8	0·56	NS
	(SD)	(6·52)	(2·90)	**		(4·71)	(3·19)		
Neuroticism	Mean	7·67	10·89	1·37	NS	7·20	9·40	1·06	NS
	(SD)	(2·62)	(4·81)			(2·64)	(3·2)		
Reasoning (AH5)	Mean	34·0	43·8	3·01	·05	35·2	43·2	1·68	NS
	(SD)	(6·61)	(3·50)	**		(8·80)	(3·71)	**	

* Low scores indicate complexity.
** Heterogenous variances (' t ' test for heterogeneous variances used).

Note.—One-tailed tests were used for the first four measures, two-tailed test for the remaining three.

TABLE 2

CORRELATIONS BETWEEN VARIABLES

	B.A.D.	C.S.	P.P.S.	S.C.	IQ	N	E
Breadth of Attention Deployment	—	-·62	-·54	·13	·31	·55	·04
Cognitive Simplicity		—	·43	-·29	·01	-·31	-·11
Persistence in Problem Solving			—	-·32	-·45	·00	·02
Self-consistency				—	-·02	-·03	·48
Reasoning (AH5)					—	·42	-·09
Neuroticism						—	-·12
Extraversion							—

The hypotheses were tested by examining differences in mean scores on the relevant tests, between students classified as using narrow and broad strategies (Table 1). Table 2 shows the inter-correlations between the tests used.

DISCUSSION

Statistical significance in the findings is, of course, severely hampered by the very small sample size, but as an exploratory study several interesting possibilities are raised and further questions emerge for future research. With the exception of the self-consistency tests the results offer support for the hypotheses and have revealed relationships between attention deployment, learning strategy, cognitive complexity and flexibility during problem solving.

The central theoretical idea concerns differences in width of attention. A person with narrow attention will learn in a controlled localised fashion considering only information of direct relevance to his current focus of interest. People with wider attention will tend to learn in a more global fashion and develop a relatively multi-dimensional conceptual system; in a problem-solving situation they will tend to attempt a wide range of possible solution routes rather than pursuing a single route until they are sure it will not work.

There may be similarities between these problem solving and learning strategies and creative or divergent thinking as described, for example, by Wallach and Kogan (1965). Differences in attention deployment may provide a common thread and as noted earlier some studies have found relationships between attention deployment and indices of creativity such as the Remote Associates Test. On a wider basis there is a recurrent theme in the literature (see Bolton, 1972, for a brief review) suggesting that the production of creative ideas is facilitated by a state of diffuse awareness or wide attention.

The results also revealed a difference in intelligence test scores between broad and narrow strategists, with broad strategists obtaining the higher scores. Another feature of the results worth highlighting in this context is that there is no clear relationship between intelligence and attention deployment, although there is a link between learning strategy and width of attention. It is also worth noting that there are significant differences in variance between broad and narrow strategist's scores on the attention deployment test, mainly due to two broad strategists who exhibited narrow attention deployment. The variances for broad and narrow strategists on the intelligence test are also heterogeneous. These results are interesting and a possible explanation is that the sort of ability needed to obtain a high score on the intelligence test is similar to that required by someone who operates a successful broad strategy in learning. This competence factor could be distinguishable from a preference factor measured by the test of attention deployment. Taken together these two factors could largely determine the extent to which an individual adopts a narrow or a broad strategy. Similarly high scores on a test of divergent thinking may be dependent on both the preferences and competence factors mentioned above. This would be consistent with earlier findings that creativity is related to attention deployment and to intelligence.

A final aspect not mentioned so far is the data concerning extraversion and neuroticism. Previous work relating these factors to differences in learning *outcome* has been reviewed by Entwistle (1972). In the current study relationships between learning *process* and these factors were examined, but the results do not provide any clear findings. As Di Scipio (1971) has shown the relationships between extraversion, neuroticism and cognitive processes can be rather complex. The current results could perhaps provide the basis for a future hypothesis that neuroticism or anxiety is related to a broad strategy. Elsewhere in this *Journal* Fransson (1977) has presented results that link trait anxiety with a tendency towards surface processing and, although in the present study all students were required to attain a deep level of understanding, learners who are high on trait anxiety may have tried to cover a wide range of topics in a relatively superficial way and tend to exhibit a breadth-first strategy. This sort of anxious focusing on different aspects of the environment is not the same as the wide or unfocused attention described earlier, but the test of attention deployment used in the current study may not distinguish clearly between the two.

The results obtained from this research cannot provide more than preliminary indications of possible relationships; they do however suggest possibilites for further research or educational experiments. An interesting and potentially valuable area for further work would' involve attempting to clarify the relationship between learning strategy, attention deployment and intelligence. Other specific issues that may be worth exploring include the possible relationship between narrow/broad learning strategies and resulting knowledge structures, and the validity and reliability of such strategies in more conventional educational settings. A more speculative area would involve investigating the effects on learning or problem-solving activity of a training regime designed to increase width of attention.

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THE PERSONALITY STRUCTURE OF BOYS IN A REGIONAL ASSESSMENT CENTRE

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SUMMARY. 202 boys entering a regional assessment centre in Britain run by the social service department of a local authority were given the HSPQ as part of general assessment procedures. The mean age of the boys was 14 years 11 months. Correlations between HSPQ factor scores and various chosen areas of functioning by the boys, measured by other tests and by rating, had not given significant results. The factor analysis of their HSPQ results on the other hand revealed two common factors, anxiety peculiar to the sample, and self-sufficiency. It is suggested that further research is needed to explore the implications of these factors for response to treatment. There was a marked affinity between the personality traits of the boys in the assessment centre with boys of the same age in the British Standardisation Sample for the HSPQ test.

INTRODUCTION

A regional assessment centre receives children for a period of assessment on several grounds. The referring agent is usually a local social services department into whose care a child has been taken and a great deal of effort has usually been made before referral to cope with the problem of the child and its family nearer home. As a rule the boys referred have committed offences against the law of the land, but other difficulties can also lead to a stay in the assessment centre.

In addition to day-to-day observation, the boys are interviewed and examined by a psychologist. The psychological examination assesses ability and also personality. In Aycliffe Assessment Centre, where this study was undertaken, the HSPQ, i.e. the Cattell Jr-Sr High School Personality Questionnaire, was given as a matter of course as a group test to boys who could read and who were of appropriate age. The anglicised version of Form A was used and scores calculated according to the British Supplement to the High School Personality Questionnaire (Saville and Finlayson, 1973). Three qualified educational psychologists worked at the centre during the period when the test data in this study were assembled, between December, 1974 up to November, 1975. In addition to the scoring of tests, the psychologists were also required to assess the degree of the delinquency of the boys according to agreed criteria.

The personality of delinquent boys has been the subject of numerous studies listed in the literature in this field. Many older studies record the use of projective type tests and the results are often inconclusive because of the low reliability and validity of the tests. Cattell (1969) refers to studies in this field including the Scottish factor analytic study by McQuaid then in press.

METHOD

Sample.

The 202 boys in this sample formed a consecutive intake of boys at the regional assessment centre between December, 1974 and November, 1975. The age range of the boys varied between 12 years to 16 years 11 months with an average of 14 years 11 months. The majority of the boys were in the 14-15 year age group. There were 12 non-offenders while the majority of the group had appeared in court and earned a rating on a five-point delinquency scale between 2-4. A graphical representation of ages and delinquency rating approximated a normal curve of distribution. Intelligence testing of the boys had shown low average intelligence, but with lower verbal functioning (Whittaker, 1977).

Weights in the HSPQ Handbook (page 41) were used to calculate second-order factor scores and some Criterion Estimate Scores. Mean and standard deviations of 'sten' scores are shown in Table 1.

These scores in Table 1 do not show a very marked deviation from normal functioning on the average, as the HSPQ Handbook points out that it is only when sten scores of 4 and 7 are obtained that a person is definitely departing from the average.

TABLE 1

MEAN STEN SCORES ON SECOND-ORDER FACTORS

Factor or Criterion	Mean	S.D.
Q I Exvia	5·10	2·19
Q II Anxiety	5·66	1·79
Q III	5·62	1·75
Q IV	5·25	1·52
Criterion Estimate Scores:		
Delinquency Proneness	5·45	1·69
Recovery from Delinquency	4·91	1·72

The raw score means and standard deviations of the boys on the 14 HSPQ source traits are listed in Table 2 side by side with the means and standard deviations of 1261 secondary school boys in the British Standardisation sample (Saville and Finlayson, 1973). No significant differences in means were evident apart from the expected lower functioning on B (brightness).

TABLE 2

MEANS AND STANDARD DEVIATIONS ON 14 SOURCE TRAITS OF SAMPLE COMPARED WITH BRITISH NORMS

First Order Factor	Aycliffe Assessment Centre		British Standardisation	
	Mean	S.D.	Mean	S.D.
A	9·56	3·39	9·84	3·46
B	5·96	1·61	7·09	2·01
C	10·39	3·34	9·85	3·47
D	10·10	3·44	10·65	3·37
E	10·26	2·94	11·08	3·11
F	9·70	3·59	10·78	3·54
G	10·26	3·61	11·04	3·35
H	10·75	3·58	10·25	3·55
I	7·01	3·45	6·09	3·83
J	8·68	3·01	9·06	3·06
O	9·22	3·23	8·34	3·34
Q_2	10·21	3·22	10·43	3·26
Q_3	9·51	3·02	10·18	3·25
Q_4	10·12	3·39	10·66	3·48

What perhaps should be borne in mind when the reliability and validity of HSPQ scores are discussed is the fact that the authors of the test always recommend the use of more than one form with the same subject. It is, however, hard to imagine how this could be achieved in the course of ordinary assessment. Both time and willingness on the part of the boys could be found lacking.

Computer facilities were used for correlations and the factor analysis. The Statistical Package for the Social Sciences by Klecka *et al.* (1975) formed the basis for the computer programme. The method of oblique rotation of factors was chosen because of the preference shown by Cattell and his collaborators for this method in the construction of personality tests. The Principal Factor direct method was used to obtain the factor matrix and the Oblimin solution in the oblique rotation.

RESULTS

When the HSPQ raw scores were intercorrelated the correlations in Table 3 were obtained. For a sample of N=202 correlations of the magnitude of 0·182 are significant at the 1 per cent level.

TABLE 3

CORRELATIONS BETWEEN SOURCE TRAITS OF THE HSPQ (N=202)

Factor	A	B	C	D	E	F	G	H	I	J	O	Q_2	Q_3	Q_4
A		15	12	-16	03	12	07	29	-05	-23	-17	-25	-02	-16
B			-07	-02	12	16	-06	02	-15	-06	08	-02	-04	07
C				-32	-02	-04	10	40	-02	-04	-43	-13	25	-37
D					10	22	-19	-24	-09	07	28	05	-20	46
E						20	-30	12	-32	-09	-04	-05	-18	-09
F							-26	22	-23	-08	-07	-36	-25	09
G								08	24	03	-13	07	35	-20
H									-02	-13	-39	-22	09	-31
I										17	02	-02	15	-03
J											15	24	04	10
O												15	-22	33
Q_2													09	03
Q_3														-22

Decimal points omitted.

The factor analysis produced four factors with latent roots larger than unity. The extracted factors accounted for only 53·2 per cent of the variance. The first factor accounted for 20·1 per cent of the variance, the second factor for 16·3 per cent of the variance and the third and fourth factors for 8·9 and 7·9 per cent of the variance respectively. A very strong case for assuming that one basic dimension existed in the personality of the boys was not evident so far.

The average communality for all 14 variables in the factor analysis was 0·532. The highest communality ($h^2=0{\cdot}643$) was reached by the primary source factor Q_2 which signifies ' group dependence *versus* self-sufficiency '. First-order factors E and F had the next highest communalities. E signifying ' sober-enthusiastic ' reached $h^2=0{\cdot}576$ and F signifying the dimension ' obedient-assertive ' had $h^2=0{\cdot}599$. The lowest communalities were seen for J and Q_3, $h^2=0{\cdot}335$ for J and $h^2=0{\cdot}405$ for Q_3. These two first-order factors obtain low equivalence coefficients and their validities are low in one-form administration according to Cattell (1969). They are, however, retained in the present factor analysis.

Table 4 shows the factor loadings after oblique rotation using the Oblimin solution. Rotation has certainly helped to clarify the first two factors particularly. The arbitrary criterion of ± ·30 has been used for the significance of the factor loadings. The significant loadings are marked in bold in the matrix.

TABLE 4

FACTOR LOADINGS AFTER OBLIQUE ROTATION

	Factor 1	Factor 2	Factor 3	Factor 4
A	-13	-28	16	**63**
B	24	17	-18	**71**
C	**-77**	-04	-05	-15
D	**56**	-27	-12	-22
E	-18	03	**-77**	-02
F	04	**-67**	-27	06
G	-14	22	**61**	19
H	**-63**	**-33**	-06	08
I	06	-12	**72**	-20
J	08	19	05	**-51**
O	**72**	16	03	06
Q_2	11	**76**	-18	-17
Q_3	**-36**	**34**	**31**	02
Q_4	**72**	-22	08	-07

Decimal points omitted.

The factor pattern shows the contribution of the factors to the variables. Many of Thurstone's postulates for simple structure are fulfilled, i.e. each row should contain at least one zero, or non-significant value, and for each pair of factors there should be several variables with zero loadings on one factor and significant loadings in the other,

It can usually be expected that correlations between factors exist in oblique resolutions, but the correlations shown in Table 5 are fairly moderate. We recall that Factor 1 accounted for the greatest percentage of the variance (20·1 per cent) and it must therefore be considered the most important finding. It has, according to the correlation matrix, little in common with Factor 2. Factor 2 accounted for the next highest percentage of the variance (16·3 per cent). In comparison with the first two factors Factor 3 and Factor 4 account for a very modest part of the variance (8·9 and 7·9 per cent respectively), but they appear nevertheless to be fairly independent factors.

TABLE 5

MATRIX OF CORRELATIONS BETWEEN FACTORS AFTER ROTATION WITH KAISER NORMALISATION

	Factor 1	Factor 2	Factor 3	Factor 4
Factor 1		02	-15	-17
Factor 2			16	-08
Factor 3				-06

Decimal points omitted.

TABLE 6

MATRIX SHOWING FACTOR SCORE COEFFICIENTS AFTER OBLIQUE ROTATION ON 14 HSPQ PRIMARY SOURCE TRAITS

	Factor 1	Factor 2	Factor 3	Factor 4
A	-04	-13	11	45
B	10	18	-10	55
C	-30	-03	-03	-13
D	21	-19	-06	-18
E	-07	06	-44	00
F	02	-41	-12	-02
G	-05	13	34	17
H	-24	-19	-02	02
I	02	-13	41	-15
J	02	08	01	-36
O	28	10	01	08
Q_2	03	48	-15	-07
Q_3	-14	20	16	04
Q_4	27	-15	06	-05

Decimal points omitted.

The weights needed in order to obtain Factor 1 and Factor 2, the most important factors found, are taken from the Matrix of Factor Score Coefficients in Table 6. They are listed below.

HSPQ PRIMARY SOURCE FACTORS

	A	B	C	D	E	F	G	H	I	J	O	Q_2	Q_3	Q_4	Constant
Factor I		·1	−·3	·2	−·1			−·2			·3		−·1	·3	4·8
Factor II	−·1	·2		−·2	·1	−·4	·1	−·2	−·1	·1	·1	·5	·2	−·2	5·6

With reference to Table 4, showing the factor loadings, an interpretation of all four factors obtained in this study of the personality structure of 202 boys with varying degrees of delinquency is attempted next.

Factor 1. Factor 1 has negative loadings on C and H and positive loadings on D, O and Q_4. Using the well-known interpretations of these HSPQ primary source factors the most significant characteristics of Factor 1 are: emotionally less stable, threat-sensitive, excitable, insecure, tense.

Factor 2. Factor 2 has negative loadings on F and H and positive loadings on Q_2 and Q_3. A tentative interpretation of Factor 2 is thus: serious, shy, self-sufficient, controlled. Prefers own decisions.

Factor 3. Factor 3 has negative loadings on E and positive loadings on G, I and Q_3. The interpretation of Factor 2 points to: being easily led, conscientious, sensitive, also controlled.

Factor 4. Factor 4 has positive loadings on A and B, and a negative loading on J. The interpretation of Factor 4 is thus: warm-hearted and participating, bright, likes group action.

DISCUSSION

The factor analysis of the Cattell High School Personality Questionnaire given to a sample of boys passing through a British regional assessment centre yielded two recognisable second-order factors. The first one pointed to a marked degree of anxiety, insecurity and tenseness in the boys. The second factor showed that the sample included sober, taciturn and serious boys with self-control and a preference for making their own decisions, although small sample size indicates a need for caution in interpretation.

When straightforward second-order sten scores for Anxiety were calculated with the weights given by Cattell (1969), the present sample did not obtain high anxiety scores, nor any marked deviance from the norm on the Exvia-Invia second-order factor. The weights given by Cattell in order to obtain a subject's Anxiety score are different from those in the present study used to obtain Factor 1 the characteristic of which is anxiety. The American anxious youngster was apparently less emotionally unstable, more happy-go-lucky, had a weaker superego, was more of a joiner of groups, had less self-control and also less tension. The differences are indeed quite marked.

Cattell has said that anxiety shows the highest variance among children and its relationship to treatment is a complex one. Pierson and Kelly (1963) and Pierson *et al.* (1966) have also discussed this. Cattell has suggested that high anxiety perhaps is produced by ego weakness (C–), ergic tension (Q_4) and superego threat (0) in guilt proneness. Some such ingredients, or interaction, could well have produced the anxiety evident in this study. The question remains whether the anxiety shown is a good predictor for treatment. Pierson is reported to have included heightening of anxiety in the treatment of non-anxious young delinquents, but other researchers have found that more extraverted and less anxious subjects responded better.

We recall that the HSPQ so-called Recovery from Delinquency–Criterion Estimate Score showed very inconclusive results in the Aycliffe sample. Pierson (1965) produced a specification equation for response to treatment which also was used with this sample. The mean outcome was an incredibly high positive response to treatment with a mean sten score 10·38 (S.D. 2·19). The particular traits which Pierson thought important for good response to treatment are in fact included in Factor 1 from the present factor analysis: less ego strength (C–), excitability (D), guilt feelings (0).

Very tentatively one may conclude that the personality traits demonstrated by Factor 1 are different from higher-order anxiety scores in America but that they seem to show good response to treatment using Pierson's equation.

The second factor extracted from the factor analysis with this sample of British boys in an assessment centre is more difficult to define in terms of the well-known HSPQ second-order factors. It has no affinity with those listed in the Handbook, nor does the pattern of the weights resemble Cattell's general description of the delinquent HSPQ profile. At the moment we must therefore be satisfied with the notion that the type of boy Factor 2 describes —serious, shy, self-sufficient and controlled—passes through a social agency such as an assessment centre in fair numbers.

A comparison with other research in Britain (McQuaid, 1970) shows that a Scottish sample of almost similar size produced a second-order factor which approximated Cattell's combined 'Anxiety' and 'Introversion' second-order factors. The differences between McQuaid's results among an approved school population in Scotland and the present results are worth considering since at least five years of social change and different criteria for admitting a boy to an assessment centre and community school could be responsible for the different characteristics of the later sample. McQuaid found no F− (sober, taciturn, serious) or Q_2 (self-sufficiency) in his sample of 250 delinquents in Scotland, while they are prominent in Factor 2 in the Aycliffe sample in this study.

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CONFERENCE ABSTRACTS

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PATTERNS OF COMMUNICATION IN THE DEVELOPMENTALLY YOUNG

The degree to which individuals can accommodate to another person's perspective when they verbalise about their environment has been termed ' taking the role of the other ' and is often considered in relation to the Piagetian notion of egocentrism; the hypothesis being that the more egocentric a speaker is, the less likely he is to identify the aspects of the communication situation which are important to his listener.

This paper reported a number of studies by both authors which suggest that this type of explanation is an over-simplification of the issue. These studies, with both normal and retarded children, suggest that the ability level of the listener, the nature of the stimulus material, the degree and type of feedback, the child's personality, and experience in the task are all important to communicative performance.

The paper also considered examples of communicative language used by the developmentally young and used these examples to build up a model of the rules of communication as seen by the children studied.

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PROMPTING CHILDREN'S SEARCHES FOR OBJECTS: AN EXAMPLE OF MOTHERS' TUTORING BEHAVIOUR

Mother-child interaction has been the topic of considerable research interest during the past few years. Implicit within much of the work in this area is the view of the mother as a teacher and model for the child's behaviour. The experiment to be reported examined the type of information mothers use to draw their children's attention towards particular objects. The study is based on observations of 32 mother-child pairs engaged in an object retrieval task. Half the children were 24-months-old; the remaining 16 were 30-months-old. Each child was required to locate three familiarly-named and three unfamiliarly-named target objects. Five different types of information were identified amongst the mothers' prompts: naming, deictic, location, description, and background clues. A comparison of the relative frequency of each category of prompts revealed age-related differences; mothers of 24-month-olds stressed the objects' whereabouts whereas mothers of 30-month-old children were more concerned to establish the nature of the target-objects for their children. This shift in emphasis in the way mothers present the task is discussed in the light of other recent studies which have examined mothers' tutoring behaviour (Kaye, 1977; Wood and Middleton, 1976).

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THE DEVELOPMENT OF ADOLESCENT THINKING IN 1710 SUBJECTS WITH AN AGE RANGE OF EIGHT TO ADULT

A test of adolescent judgment, two tests of creativity, a test of concept formation, and a test of concept attainment were administered to a sample of 1710 subjects covering the age range 8 : 10 to adult. The purpose was to chart the development of formal thought, as defined by Piaget and Peel, from childhood to adulthood and to identify some of the factors that contribute to it.

The results confirmed the findings of previous workers that it is in the age band 12 : 0 to 14 : 0 that most people develop the ability to think formally; but also showed (1) that in some intellectually bright children the development can be earlier and (2) that even in adults there is a tendency, on some occasions, to regress to a lower level of thought. Age and intelligence were shown to be contributing factors to the development of judgment and the form of presentation of the material to be judged was shown not to have any really significant effect unless other factors were also present. The results of the investigation of other contributing factors, for example creativity and social class, were inconclusive because of experimental and conceptual difficulties.

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ADOLESCENCE: RELATIONSHIPS WITH AUTHORITY

In the recent literature on adolescence remarkably little attention is paid to the ways in which young people's attitudes to authority alter during this period. This is an issue which is of obvious importance, most especially in the educational context. In this paper results from three different pieces of research were reported. In the first place evidence was presented to show how attitudes to various authority figures become modified during the period 11 to 17. Secondly, results from attitudinal study of both adults and adolescents were discussed, illustrating how each group perceives the other, and in particular highlighting important areas of agreement between the generations. Thirdly the paper was concerned with the needs of adolescents, typical adult-adolescent conflicts, and preferred resolutions of such conflicts. The presentation of these pieces of evidence made it possible to summarise our present state of knowledge on adolescent attitudes to authority, to indicate directions for further research, and to draw out the implications of this work for the area of teaching and learning.

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SPATIAL DEPTH RELATIONSHIPS IN YOUNG CHILDREN'S DRAWINGS

Recent research suggests that in their drawings children under seven do not attempt to portray a depth relationship between two objects (Freeman *et al.*, 1977).

In the present study, when two objects arranged one behind the other were presented as a ' model ', children drew them side-by-side just as they did when the objects were actually arranged side-by-side; however, the drawings could be distinguished by the order in which the objects were drawn. When the objects were arranged one behind the other most children drew the nearer object first, whereas there was no preferred order of drawing when the objects were placed side-by-side.

Furthermore, when the children's attention was also drawn to the spatial depth relationship between the two objects (by using the verbal terms ' behind ' or ' in front of '), most children drew the objects one above the other. There was no preference for the order in which the two objects were drawn.

In their drawings, most young children *do* distinguish between a depth and a side-by-side relationship *either* by the order in which they draw the objects *or* in the way they arrange them on the page.

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SOCIAL HANDICAP AND COGNITIVE FUNCTIONING IN PRE-SCHOOL CHILDREN: A CURRICULUM DEVELOPMENT PROJECT

Earlier programmes designed to help socially handicapped children have been shown to be of limited value and to have 'wash out' effects after 2-3 years (Woodhead, 1977). Many of these have been biased towards cognitive and linguistic skills whereas this project has attempted to look at additional factors which affect the child's ability to cope successfully with the normal school learning process.

Phase I investigated a number of aspects of the problem including in particular, powers of concentration, motivation, ability to co-operate with adults and ways of problem-solving. From these findings and intensive discussions at teacher group meetings throughout the country it appeared that socially disadvantaged children were less able to:

(i) use social skills to deal with peers and adults,
(ii) attend to tasks, particularly those which are school orientated,
(iii) use previous experiences to solve new problems.

Phase II of this research (the curriculum development phase) set out to identify the particular needs of these children and with the help of practising teachers design materials and strategies which might help children overcome their difficulties. These ideas were formulated into a curriculum with a thematic approach, which has been tried out in approximately 130 schools in England and Wales.

During the trial period teachers were asked to work with two groups of children over a period of two terms. Each group contained two boys and two girls aged between 45 and 54 months, two of whom were considered disadvantaged and two non-disadvantaged. All children were pre- and post-tested. An in-depth study has been made on 64 children in eight schools. The results are not yet available but initial reactions have been favourable in terms of teachers' and children's attitudes.

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A NEW METHOD OF ASSESSING CHILDREN'S SPONTANEOUS RESPONSIVENESS TO ORIENTATION: USE OF DRAWING TASKS

Representational drawing certainly involves the use of mental imagery. But mental images cannot be projected on to paper; instead the drawing has to be constructed into a graphic image which may or may not map on to the child's mental image with reasonable fidelity. Further, the child may have to transform his initial mental image, subjecting it to certain transformations such as rotation or selective deletion. Thus it is a very considerable leap from analysis of what the child draws to what the child thinks, knows, or feels.

In considering the processes which necessarily intervene between the mental image and the graphic image, we have been led to the view that a large number of variant forms in drawing, such as the 'tadpole-figure', can be accounted for in terms of performance problems. The child may know what to do, but cannot quite manage to do it. Experiments can easily demonstrate this. The child has to deal with a specifiable set of *task demands*, such as seriation and relative orientation. At various stages of development, children make use of certain cues to guide their drawings; and these cues often differ considerably from those used by adults.

The experiments reported here stem from this type of analysis. We can now build certain cues into the drawing situation and see how responsive the child may be to them. By giving incomplete drawings in which the page is variously rotated and contains a pre-drawn face, also rotated to various degrees, we have been able to show the extent to which normal children from 3 to 6 years can spontaneously co-ordinate two disparate orientation cues. So can many ESN(s) subjects.

This provides an indirect test of ability of a new type. The children will demonstrate their abilities if they are not overtly required to do so; and these children are often ones who refuse, or fail to deal with, overt tests of orientation-responsiveness. Thus we can probe the extent to which, say, children with writing difficulties are actually capable of mastering some of the skills relevant to graphic ordering.

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SERIATION MADE SIMPLE

Piagetian seriation tasks typically involve the ordering of a number of rods (usually about 10) in a horizontal series according to their length (e.g. Inhelder and Piaget, 1964). Systematic competence on these tasks does not generally occur until the stage of concrete operations at about 7 or 8 years old. However, when the elements in the series are blocks to be stacked in a tower or cups to be nested inside each other competence is achieved by the age of 3 or 4 years (Inhelder and Piaget, 1964; Greenfield *et al.*, 1972).

The aim of the experiment reported was to shed more light on the relationship between the easy and the more difficult seriations as shown by the performance of children who are likely to succeed on the easy tasks but fail on the more difficult ones. Three age groups of children (3-4, 4-5, and 5-6 year-olds) undertook trials on all three tasks (linear, stacked, and nested seriations).

The linear task produced more errors than the stacked task, which in turn produced more errors than the nested task. These differences could be explained in terms of the corrections the child makes during the course of the tasks. Thus the children who made mistakes in the easy tasks corrected these whereas such corrections occur less often in the linear task. Further, the type of corrections made were different in the two easier tasks. The results were discussed in terms of the constraints the tasks impose on action.

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THE BEHAVIOUR ANALYSIS FOLLOW-THROUGH PROJECT

Recognition that the problems of poverty and of ethnic minorities are linked closely with achievement at school led the US Government to initiate a number of compensatory education programmes in the mid-1960s. *Follow-Through* was funded from 1968 as a research programme to find alternative approaches to education during the early school years, which would maintain the gains of *Head Start*. The ' planned variation ' research strategy involves evaluating 22 approaches suggested by different programme sponsors, which operate in many sites throughout the USA.

The Behaviour Analysis model for *Follow-Through*, described in this paper, is sponsored by the University of Kansas, operates in 12 sites, and caters for approximately 7,500 children. The approach concentrates primarily on accelerating the acquisition of basic academic skills within a classroom context of small group instruction (involving parents as teachers), carefully selected (commercially available) curriculum materials, and a motivational system incorporating token reinforcement procedures. Regular measurement of children's progress through the curricula enables support and training staff to provide positive feedback and assistance to all teachers.

Results between 1968 and 1975 show that Behaviour Analysis Follow-Through children are achieving at or above grade level on standard achievement tests during all four years in the programme; comparison children are falling progressively further behind. Comparative results across all Follow-Through approaches show that Follow-Through as a whole is achieving a significant impact on the educational problems of poor children, and that the Behaviour Analysis model is producing much greater effects than most other approaches.

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THE USE OF THE ANALYSIS OF CO-VARIANCE IN EDUCATIONAL RESEARCH: PANACEA OR PITFALL FOR THE UNWARY?

Over the past few years there has been a steady stream of papers in psychological and educational research journals reflecting on various problems associated with the use of the statistical technique known as the analysis of co-variance. Whilst it is important for educational researchers to be aware of these developments since co-variance techniques are increasingly employed in educational research designs, the usual style of their exposition, which is predominantly algebraic, limits their influence. It was the purpose of the present paper to attempt to present these developments in more concrete and practical terms in order to demonstrate that the analysis of co-variance is no panacea for educational research ills. It is severely limited in its valid applications whilst invalid applications may lead to a multitude of false inferences and generalisations (e.g. when the relationship between predictor and criterion is different for the two groups, or is non-linear). Moreover, the use of intact school classes as experimental groups is only partially corrected for by the use of analysis of co-variance.

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CHILDREN'S ABILITIES TO CONSTRUCT AND INTERPRET STORIES

Stories encompass many structured information situations used every day. A high level of concept formation is involved in telling and understanding stories (Bower, 1976) but little is known about the development of this ability. The present investigation was a preliminary but systematic study into the development of the ability to construct and interpret stories.

Seventy children, age range from 5-11 years, divided into seven age groups, matched for sex, intelligence, and experience of story-telling and listening to stories in the home (assessed by parental questionnaire) were asked to tell a story of their own. They were also asked to listen to a story told by the experimenter and to retell this story. Two independent judges rated what the children said, according to criteria derived from Bower's (1976) story plan.

Comparisons made of the performance of children of different ages showed that younger children were more likely to deviate from the story plan by either missing out components, or incorrectly linking, or incorrectly ordering components, than older children.

Analyses to compare a child's ability in telling stories and his ability in interpreting stories are ongoing. Evidence of a link between the two abilities will lend support to the idea that there is a story grammar, the functions of which are twofold: (i) in guiding construction and (ii) as an aid to interpretation.

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SOCIAL ROLE-TAKING IN FOUR-YEAR-OLDS

In recent years there has been considerable interest in ' social cognition ', and more particularly in children's ability to recognise and adapt to the perspective of another person (Flavell, 1968; Rubin, 1973). This paper reported research on social role-taking in a group of 60 children aged 4 years 0 months, participating in a larger longitudinal study (see Richards and Bernal, 1972).

Eight tasks were employed, some adapted from the literature, some newly developed. In two of them the child's problem was to orient an object so as to be the ' right way up ' for another person; two tasks highlighted the problem of visual interposition; two involved versions of ' hide and seek ', played with dolls; one was a social guessing game in which a penny was hidden in one of two closed fists; and the last concerned appropriate attribution of emotional expression.

Results suggested that while overall levels of performance may be highly situation-dependent, the relative adeptness of different children is very stable across tasks. The tasks may thus tap sensitivity to the need for adjusting to the other's point of view rather than the cognitive capacity to make such adjustments. Characteristics of children showing relatively good and relatively poor role-taking were discussed.

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FUNCTION VERSUS SUBSTANCE IN THE DEVELOPMENT OF THE RATIO CONCEPT: THE POTENCY OF CONTEXT

Bruner and Kenney (1966) have demonstrated that by 11 years children understand the ratios inherent in the absolute dichotomous sense of fullness (' full ' *versus* ' not full ') and Nelson *et al.* (1969) found that with training 7-year-olds performed even better on a similar comparative judgment task. However, McWhirter (in press), studying the continuous proportionately dimension of the concept has illustrated that both adults and children find the task much more problematic. In her experiments subjects were required to compute and compare degrees of partial fullness. Explication of the appropriate ratio referent improved performance but there was semantic and situational confusion from ' contained volume'. Phenomenological analysis suggests that in childhood and in common usage ' fuller ' mostly coincides with ' more ' and this has also happened empirically.

Unlike all previous investigations this group study explores the exceptional case where ' more ' is not synonymous with ' fuller'. Experimental conditions varied both verbal and pictorial representations of the comparative judgment problem with 900 adults and 900 11-year-old children. The main results indicate that with a straightforward definitional question the children produced similar responses to the adults in the verbal non-diagram condition. Overall, the inclusion of a concrete referent made the task more tractable for both groups of subjects. (Ss correct (a) diagram conditions 74 per cent adults, 20 per cent children; (b) verbal conditions 28 per cent adults, 8 per cent children.) However, varying the type (ratio; contained volume; physical dimensions and water level) of or the number of items of directive information made little difference.

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CHILD AND PARENT, SCHOOL AND CULTURE: ISSUES IN IDENTIFICATION

The data on which this paper was based came from the 7-year-old stage of the Nottingham longitudinal study of child-rearing practices, which is following 700 children representative of all social classes. Assuming that the child is already a product of his culture at school entry, having been reared by heavily culture-exposed adults, school represents a formalising of cultural pressures on the child. At this point there may be dissonance between the cultural pressures of the school and those of the home. While parents inevitably must pass on implicit cultural messages, they have some choice in how far they explicitly offer their child experience of institutions and concepts of the world beyond the family, and how far they identify with the educational intentions of the school by welcoming school interests into the home (as opposed to making school visits themselves). Massive class differences were found in indices of 'home-school concordance' and of cultural contacts provided by parents, as well as in the strategies adopted by mothers if unable to answer their child's questions. It was suggested that, while schools can compensate the child for loss of cultural contacts, there is no way of compensating him for the loss of that voluntary involvement of the parents which identifies his educational and cultural interests as theirs also.

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COMMON FACTORS IN REPRESENTATIONAL PROCESSES OF NORMAL TWO-YEAR-OLDS AND OLDER ESN(S) CHILDREN. THE WORK OF THE BRISTOL TEACHERS' RESEARCH GROUP

Recent research in language development has demonstrated the importance of responsiveness to context in young children. In the limited domain of the acquisition of spatial relational terms, researchers have suggested the existence of specific processing strategies which permit non-linguistic object knowledge to be mapped on to the emergent linguistic system (Clark, 1973).

The research to be reported investigates children's strategies in structurally similar linguistic and non-linguistic tasks. The employment of this research design permits a close comparison to be made between normal speaking two-year-olds and older mentally handicapped children who have not attained speech. The results clearly demonstrate that both types of children are employing similar strategies in dealing with representational problems. These strategies derive from responsiveness to non-linguistic, contextual cues. The priming-up of cue-sensitivity is our starting-point for the development of a specific remedial and testing programme.

The implementation of the research has depended upon the involvement of a group of teachers in special education from the inception of the project. They have played a full participant role in both design and execution.

The successful operation of the joint psychologist/teacher research group required the fulfilment of two conditions: one was the negotiated overcoming of the separation between the professional roles of ' teacher ' and ' researcher'. The other was the optimal utilisation of the teachers' unique knowledge of their particular children in conjunction with psychologists' access to standardisation, validation, and reliability criteria. The group members are now in a position to formulate rules of evidence capable of encompassing the behaviour of a diagnostically disparate group of ESN(s) children.

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ON SHARED KNOWLEDGE: TEACHERS AND SEVERELY SUBNORMAL CHILDREN

Despite enormous efforts expended in research on language and on teaching, we remain strangely ignorant about how an adult comes to make things known to a child. The research reported attempts to answer some aspects of this immense problem in the relatively simple context of a teacher teaching three of her severely subnormal (SSN) children how to assemble a toy, a task which involves a knowledge of colour, shape, and size.

In order to communicate effectively the teacher needs to know how much knowledge is shared with each child, and to adjust her strategies accordingly. This paper looked at questions such as (i) How much knowledge is actually shared between child and teacher? (ii) What opportunities are there for the teacher to find out what is shared? (iii) How does she use such opportunities to alter her strategies in teaching children of widely different ability? (iv) What sorts of adjustments does she make?

Analysis of the interaction is based on speech act theory (Searle, 1969) and work concerned with the relationships between communicative behaviour and the extralinguistic context (Olson, 1970; Rommetveit, 1974). It employs three sets of parameters: (i) primary act type (command, statement, etc.); (ii) the underlying proposition of the act (its domain of reference, subject, and specified action) and (iii) the realisation of that proposition in terms of semantic and syntactic complexity.

Results show firstly that the three children described are ostensibly different in ability and interactional characteristics, Secondly, the teacher, whilst failing to take account of some differences, such as the amount of initiatory activity of the child, does alter her strategies in other respects, such as the semantic complexity of her demands.

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INTERSUBJECTIVE EXCHANGE AND TRANSFER OF UNDERSTANDING IN INFANCY

Recent studies of infants show they have rudiments of intentional action towards objects. No less remarkable is the finding that they also have human understanding. They possess elaborate awareness of persons, complex expressiveness, and an ability to participate in intimate interactions (Trevarthen, 1974, 1977).

Communication reaches a maximum in primary form immediately after the period of neonatal dependency, in the second and third month (*Primary Intersubjectivity*). Competitive epigenesis of person-directed and object-directed behaviour in months 4-8 results in indirect communication through games. Pleasure and excitement in games involve a complex interpersonality, but this communication lacks a separate external reference.

A transformation at 9 to 10 months reinstates direct interpersonal messages for their own sake, and now the communication is capable of carrying reference to a distinct external and mutually acknowledged topic. This is the period of Halliday's ' protolanguage ' (Halliday, 1975). The infant may indicate a topic for joint attention and initiate familiar games.

Examples of reciprocal exchange of topics and the acceptance of directives by 9-12-month-olds will be shown. The development of this *Secondary Intersubjectivity* proves that an adaptation for co-operative understanding of the world is inherent in infants. Its epigenetic regulation determines when communication of meanings will direct the child's learning. From this point a system of education may be established. The fact that it arises principally within the infant, in suitable conditions of personal care, has revolutionary implications for psychological theory.

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COGNITIVE DEVELOPMENT AND EDUCATIONAL PRACTICE: PUPIL PROGRESS IN PRIMARY SCHOOL MATHEMATICS

Our analysis of the primary school mathematics curriculum suggests that theories of cognitive development, principally those of Jean Piaget, have been the seminal theoretical influence upon the practices of primary school mathematics. Piagetian concepts have been incorporated into teachers' taken-for-granted understanding of how children learn mathematics, into explicit theories of mathematics teaching, and into the commercially produced schemes widely used in primary schools (e.g. Mathematics for Schools and the Nuffield Mathematics Project). Indeed, Piaget's theories are often cited to scientifically justify what the Plowden Report called ' New Mathematics '.

This has led to the assumption that progress in mathematics is an integral part of the child's cognitive development and that school mathematics fosters development, such that pupil progress is interpreted as an index of an underlying developmental process.

Our work suggests that this view of the relationship between development and pupil progress is incorrect, and points to an alternative account, which will be supported by observational data from our work in a primary school. This focuses particularly on the effects of the structure and content of the mathematics programme and classroom organisation on the progress of two pupils with different levels of attainment.

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STYLES ADOPTED IN SOLVING ARITHMETIC TESTS AND THEIR RELATIONSHIPS TO A COGNITIVE STYLE AND SOCIAL BEHAVIOUR

On an arithmetic test pupils may obtain equal scores in different ways. This project examines these different styles, their relationship to a more general cognitive style, Witkin's Field Dependence (Vernon, 1972; Witkin, 1965), and also to social behaviour.

Just over 100 11-year-olds each produced a set of scores from two parallel mechanical arithmetic tests. These were numbers of items omitted, number of items altered, number of items correct, accuracy and variation between totals correct on two tests. They also completed Witkin's Embedded Figures Test, Raven's Matrices, the Crichton Scale, JEPI and Jesness Inventory. Their absenteeism rates were noted and teachers named pupils whose behaviour worried them.

The cognitive style was evident in the arithmetic: field dependent pupils were inclined to omit items, make errors, and vary their final scores on parallel tests—even with ability partialled out.

These three arithmetic variables, EFT and ability scores were related to Jesness social maladjustment scores. Teacher selected pupils' scores confirmed these relationships.

Frequently-absent pupils divided into distinct subgroups: in one pupils were inaccurate, omitted items, had low EFT and high maladjustment scores—some were teacher selected as troublesome. Pupils in the other subgroup were the opposite in these variables. Thus, for example, the relationship between arithmetic omissions and school absence was curvilinear. This was confirmed in another sample.

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In the Open Books Series *Psychology and Education,* General Editor G. Cortis. p. £1·95, c. £4·50 per volume.

This is an important series. The classic teaching texts in educational psychology in this country, for example, Peel, Lovell and Stones, are single books. Now, for what may be the first time, a British series in educational psychology has appeared. The individual volumes are admittedly small—on a quick count I estimate each to contain between 50/60,000 words—and the format also indicates the influence of modern modular approaches, but to this reviewer this series signals a growing subject and thus a consequent break with the single-book publishing tradition.

The editing has produced five texts of handy pocket size, with a pleasant and intriguing cover. Each book carries about 100–150 references and there is an interesting uniformity about the length and format of each member of the series. The Cortis text nevertheless appears to be the only one to include some references to further reading. The series is remarkably free from typographical error and the general effect is attractive.

The principal aim is stated as " the introduction of psychological concepts important to educational theory and practice." The audience to whom these concepts are introduced is an audience of students. The books are designed for them.

The overall content is based on the editor's survey of teachers of educational studies in colleges and polytechnics, carried out in 1973. The five titles are the ' most essential ' elements in the psychological area of education, according to the sample survey. It would have been interesting to have had more details of this inquiry. For example, was the question of the weighting of the elements pursued? One topic which is rated ' most essential' may occupy a much smaller part of the course than another topic which also receives a ' most essential ' categorisation. ' How essential ' and ' how much coverage? ' are two different questions.

Equally it would have been interesting to have sought the views of students, since the series is directed at them. Of course the views of teachers are vital. But do the views of students deserve weight too? It is an intriguing development to base a series on widely-sampled consumer research, but it is a development which needs careful consideration. Cortis makes the correct point that consumer preference alone is an insufficient guide to the choice of topics. But the ways in which the structure of the series departs from consumer preference are not indicated and it would have been valuable to have had some discussion of them.

What of the topics actually chosen? Perhaps the assessment and research area is poorly covered in the series; perhaps language and its development might justify a more substantial section than the chapter in Brown; perhaps, since teachers are increasingly teaching across the life span and not just across ten years of compulsory schooling, the psychology of adult development and learning might have been added: nevertheless on balance this reviewer would not have emerged with a very different set of five titles. But the balance of the content within the series would have been different and this is examined below.

The Cortis text is an up-to-date treatment of aspects of the social psychology of education. The text is directed at the teacher (the university teacher that is) and not at the student. For example, the section on interaction analysis skills contains no exercises which a student might be expected to carry out. This is in contrast to the message of the importance of input *and output* which Riding so forcefully and clearly expounds in his volume in the series. So one is led to conclude that like the authors of so many other texts Cortis expects the teacher to provide the exercises which students require in order to grasp and to understand the techniques which he is ably describing. The book itself is clearly written (though the table setting out the Madsen Becker and Thomas results on page 124 is an exception). It covers its theme sensibly and helpfully and should be well received.

The boundary between theoretical educational psychology and child development is difficult to draw. It might be argued that Brown draws it to include a little too much theoretical educational psychology. For example, the section on concept formation discusses work on experimental studies in concept formation, whereas the development of concepts would seem a more critical and important topic to cover in this section. This is perhaps a matter of opinion but there can be little doubt that Brown has been given a very difficult task. It is virtually impossible to cover those concepts in child development which are important for educational theory and practice, at a level which might be suitable to undergraduate students, within the confines of a 50,000-word book. The topics have to be condensed and dealt with rapidly. Although Brown struggles manfully one cannot help but draw attention to the discussion of research design and research methods in the study of child development, which is limited to just over seven pages or approximately 2,000 words. This is an example of the problem of relative weighting, to which attention is drawn above. There is more than enough material for Brown, who knows the literature well, follows a modern approach and can write clearly and cogently, to have written two volumes. The series would have been better balanced had it been extended in this way.

The Leach and Raybould book follows a quite different approach. Whereas the earlier texts tend to to give frequent references to theoretical studies, *Learning and Behaviour Difficulties in School* is clearly a practical book, aimed at inculcating practical skills. It is also the book which more than any other in the series is directed at the audience to which the introduction refers, namely the student. The book is well planned and covers areas of great interest and concern, although more examples of the themes on which the authors touch would have been useful. Thus on pages 59ff. the topic of norm-referenced tests is introduced. But the reader, who may well be meeting this topic for the first time, will want to know what *is* a norm-reference test. It would have been helpful for him to have examples illustrating the differences between norm-referenced tests and other tests so that the meaning of the term could be clarified. A similar point applies to the authors' discussions of concepts of reliability and validity, which are covered in three or four lines. Presumably there is an assumption that these ideas will have been met beforehand by the students.

There are, of course, difficulties in trying to teach practical skills through a written volume, difficulties which the authors appreciate, and which they meet well. For the practising teacher with a little background in theory, this will be a helpful, sound and sensible text.

Fontana is not one of those authors who succeed in reducing inherently interesting topics such as personality to dullness. His volume is very well written and he has an attractive and engaging style. As with Brown, the main question is one of balance. After two good chapters, the second of which leans fairly heavily on Erikson, as the author acknowledges, there follow three chapters of personality theories. Indeed one could almost include chapter six, too, as an additional treatment of personality theory. But whereas Brown exemplifies ' comprehensivity ', Fontana exemplifies ' selectivity.' Thus his chapter on personality development which leans heavily on Erikson, is one acceptable way of dealing with this area. But should not Gesell deserve at least one reference? And Bowlby?

This emphasis on theoretical approaches, important though it is and well written though it may be, has inevitably squeezed out other topics which one would have liked to have seen included in this volume. The question for example of children's attitudes to school and to teachers might have deserved more attention in a volume in a series on psychology and its implications for education. At the end of this enjoyable book—and Fontana does deal very well with personality theories—there remains the impression that here was an author who could well have written a much bigger book.

Riding has produced a well-written, well-organised book on school learning and has put his principles into practice in a clear and attractive way, The book is based on short-term memory and long-term memory as important explanatory principles. One can readily accept this as one approach to the topic of learning but it might have been interesting to have dwelt at a little more length on alternative approaches. However, the author does succeed in enlivening what is often made into a rather dull topic. More than that, he sets the reader questions to consider at the end of each chapter and includes activities designed to illustrate principles which the book is discussing. All in all this seemed an ideal volume both in content and in approach. Like Leach and Raybould, Riding will appeal directly to the student. It is of course wrong to expect uniformity of approach throughout a series of five books, but Riding does seem to illustrate a model style for a student-directed series.

In planning a series there are two alternative strategies to consider. Either each individual volume stands on its own, with the consequent duplication of subject matter which is relevant to more than one volume, or the series is conceived as an integrated whole, in which case duplication is avoided through cross-referencing to the other volumes where needed—but single volumes then may fail to give adequate treatment of the topics. Most series steer a more or less successful course between these two extremes.

This series approaches much more closely the first of these two polarities, that is, single volumes which can stand on their own. In this case some repetition of subject matter is inevitable and to give an example, Freudian theory is described in Brown's chapter on ' Personality and Social Development ' and again in Fontana's chapter on ' Psychoanalytic Theories.' Since the treatment in the two books is different the student might well ask for a brief explanatory note, or at least a cross-reference from one book to the other. Other examples of overlap exist and the series, as a unified series, would have been improved with just a few cross-references (apart from Cortis's own volume it is as if the individual authors are unaware of the content of their colleagues' volumes). The problem is largely one of overlap and different treatment, and not one of inconsistency. Nevertheless the reader may be puzzled by the different uses of the term ' isolate ' and indeed by the different approaches to sociometry in *The Social Context of Teaching* and *Learning and Behaviour Difficulties in School* respectively.

In sum this is a useful series with some weaknesses in the areas of balance and co-ordination. The topics themselves are soundly chosen, the academic level broadly right and, on the whole, the standard of writing good and in some cases excellent. The market research approach of the editor together with a uniformly attractive and practical format indicate that the series will have wide appeal.

PHILLIP WILLIAMS.

CRONBACH, L. J., and SNOW, R. E. (1977). *Aptitudes and Instructional Methods.* New York: Irvington, pp. xviii + 574, £25·00.

This book is addressed to psychologists and educators who wish to acquire knowledge about how a person's characteristics influence his response to the alternatives educators can offer or invent. The old mandate in education was, they claim, ' the institution is given, try to pck persons who fit it.' The needed mandate, which also provides another definition of equality of opportunity, is ' try to design enough treatments so that everyone will be able to succeed in one of them, and route the person into the one he fits.' This may be a laudable mandate but do we know what principles govern the matching of the learner and instructional enviroment? The book attempts to assess this by addressing two basic questions—' What person variables interact with what treatment variables? ' and, because they are very critical of research attempts so far, ' What methods of investigation should be pursued in order to add to knowledge of this kind? '

The first few chapters address the latter question. They admit that ATI research is fraught with methodological and conceptual difficulties but are clearly unhappy with the research effort to date, claiming that the research methods commonly used are inefficient and produce misleading results. Their criticisms are sweeping. Experiments have suffered from brevity and artificiality. Samples have been too small and unrepresentative. The subjects have rarely been familiarised with the task. Instructional situations have been inadequately conceptualised, often ignoring the fact that they are multidimensional. Treatments have not been monitored by observational techniques. In the chapters on statistical methods they deplore the reification of significance levels since inferential statistics should be subordinate to descriptive statistics. They suggest that significance levels be discarded in favour of confidence levels. In this context they also claim that poor reporting is endemic. It is also interesting to note that they feel that the best studies methodologically were carried out before the expansion of educational research in the 1960s. A point for the ' more means worse ' brigade.

There follow two chapters on the conceptualisation, or rather a parsimonious reconceptualisation of aptitudes. ATI research seeks to establish generalisations relating treatments to characteristics of indviduals; and thus theories which insist that general ability be fragmented into specific abilities, and that personality be considered as dozens of interrelated traits, cause embarrassing methodological problems—hence the need for parsimony. The authors deplore the current fashion of decrying general measures of ability. They stress throughout the book that general aptitude tests predict amount of learning or both—' the hare maintains his advantage over the tortoise.' They provide plenty of evidence to support this, and along the way demolish Bloom's work on stability and change in human characteristics, claiming it to be based on statistical artifact, and Guilford's SI model as being inappropriately elaborate. The theme here is that instructional treatments are not likely to iron out individual differences which surely undermines the case they are attempting to make. But no, their claims for ATI are modest, unlike those made for Mastery Learning, for example, which they dismiss as naïve.

More parsimonious reinterpretations of personality characteristics are also made. Anxiety, lack of confidence, dependency, neuroticism, compulsiveness etc. are lumped together to form a syndrome of self-deprecation. Although these traits do interrelate, their case here seems less strong and no empirical evidence is presented in justification.

In the final eight chapters their methodological and conceptual prescriptions are brought to bear on previous studies, some of which they re-analyse. These chapters cover a wide field—programmed instruction, reading and mathematics, less verbal instruction, variation in curriculum, cognitive styles, anxiety, and personality and learning. The relevant studies are reviewed and sifted into good, bad or indifferent although it is occasionally not clear why some results are discarded and others accepted. This approach provides a striking contrast to that of Gene Glass for example who, after reviewing related areas, argued that so-called well designed and poorly designed studies give very similar results, the difference being so small that to discard ' poorly done ' studies is to discard a vast amount of important data. It is thus likely that a review of the same research by Glass would provide a different picture to that painted by Cronbach and Snow. Whatever the merits of the reviews they are certainly pessimistic ones. We are informed that we cannot generalise about programmed instruction as a variable, that research on reading and mathematics shows no convincing conclusions, that it is impossible to provide a summary on cognitive styles, that two decades of thinking about anxiety and arousal have not yet brought the phenomenon under control so that effects can be predicted or even replicated, that evidence on motivation is clouded, and that prediction directly from trait scores can do no more than turn up fluctuating and inexplicable results. It is not surprising that they conclude that no ATIs are so well confirmed that they can be used directly as guides to instruction.

Nevertheless in the conclusion they re-affirm their faith in the fact that ATIs will be found to be generalisable—that they are elusive rather than illusory as some critics maintain. However, if their belief in intractability of general ability is supported, the effects can only be expected to be small.

The book is subtitled *A Handbook for Research on Interaction* and is obligatory reading for those interested in this area. Their methodological and conceptual prescriptions will not be accepted by all and others may dispute their pessimistic summaries of previous research. But this remains a seminal work and a necessary addition to the library shelves. At £25 a copy it is not likely to attract many individual sales.

NEVILLE BENNETT.

EYSENCK, H. J., and EYSENCK, S. B. G. (1977). *Psychoticism as a Dimension of Personality.* London: Hodder & Stoughton, pp. xi + 232, £6·50.

Over the last ten years the importance of psychoticism as a dimension of personality in Eysenck's system has become more and more apparent, as articles have appeared on various aspects of it, scattered over a wide variety of journals. Research had been hindered (a) by the absence of an easily used test, now remedied by the EPQ, and (b) much more importantly, by the difficulty of trying to weigh up all this far-flung evidence This new book by the Eysencks now removes this obstacle. In it is collected together almost all the research related to the Eysenck factor, and it is submitted to a critical discussion and analysis At the outset, therefore, we can say that this is a fundamentally important book for anyone interested in the factorial study of personality: one of Eysenck's best.

One point to note is the absence of polemic. In the first chapter on psychoticism as a dimension of personality, there is considerable stress on the broad agreement between the work of Eysenck and Cattell in this area and there is a reasonable note of caution in discussing the results. Thus, readers can rest assured that this is not another medieval disputation about the number of factors to put in a rotation but a careful attempt to assess the factorial and other evidence relative to psychoticism.

A good deal of the central portion of the book is taken up with chapters describing the construction of the P scales. There can be little doubt that within the limits of practical test construction, these are well-developed, reliable tests Indeed the present reviewer could only wish that this information had been in the manual to the EPQ for it is essential for a proper understanding of this test. Incidentally, there is an illustration on p. 99 of this book which strikingly supports the psychoanalytic claim that pictures of feet can be interpreted as sexual symbols, a point studiously ignored by the authors.

Chapters 7 and 8 are perhaps the most important where criminal, psychotic and antisocial behaviour are linked up to scores on the P factor. It appears that psychotics and prisoners do have the highest scores, followed by drug addicts, personality disordered subjects, those with sex problems and alcoholics. It further appears from analysis of the L scores, that psychotics and neurotics would have scored even more highly had they not lied. Convincing evidence for the validity of the P factor comes from the fact that there is a correlation between P scores and severity of psychotic symptoms.

What then is this factor P? Eysenck shows that the high P scorer is solitary, troublesome, cruel, lacking in empathy and feeling, hostile, sensation-seeking and with a taste for the odd, although the Eysencks are keen to stress that a high P can be interpreted only in the light of a subject's other personality factor scores.

A book so packed with information as this cannot be given an adequate, brief review. However, there is no doubt in this reviewer's mind that this book is a valuable addition to our knowledge. In fact, it must be essential reading for all psychologists who claim to work in the field of personality.

PAUL KLINE.

FITZGERALD, R. T., MUSGRAVE, P. W. and PETTIT, D. W. (1976.) *Participation in Schools? Five Case Studies.* Victoria, Australia: A.C.E.R., pp. 202, $10·00.

The research reported in this book was done in five Australian secondary schools. It arose out of the changing political and social context in which schools were currently functioning. In the particular context of the study, the political changes reflected a desire on the part of certain state and national bodies that teachers and students should have greater curricular freedom and that there should be greater student involvement, and wider community participation, in educational policy-making. The way the schools reacted to the social and ideological forces associated with this climate, as they are mediated by the local community, was the focus of the study.

The first chapter describes the development of the project and the conceptual framework which emerged in the course of the project. This account relates how the design of the study was radically altered mid-stream and how the conceptual framework was changed twice in the course of the collection of the data. The initial design had been a traditional 'scientific' one involving the development of broad hypotheses on the basis of data collected by interviews and participant observation in one school, later refinement of the hypotheses by work in a second school prior to wider testing by questionnaire in a more representative sample of schools. This design was dropped and two rural schools and a new urban community school which had been specifically created to develop school-community links were added as further case studies.

The initial conceptualisation had been in terms of observer-based, static, descriptive notions of role set, perceived role conflict and role strain. The revised framework remained essentially sociological in nature. Schools were structurally conceived to have goals, members, boundaries, and social networks with leaders, linking them to the community.

The definitions of the situation put forward by the people in the school and community networks were the link between the structural concepts and the activities which the researchers observed in the schools. The people in the schools were regarded as actors and the phenomena of social change was held to occur through actors who try to alter and control their situation according to changes which occur in the way they define that situation. Alterations in their definition of the situation were held to be sociologically attributable either to the structural constraints of the organisation or to developments outside the organisation such as changes in the ideology prevalent in society.

Using this framework, the authors distinguish the four traditional schools from the specially created community school. In a review, it is difficult to do justice to the wealth of interesting and diverse observations that they offer about the schools. Only one or two examples will therefore be given to illustrate the general conclusions that they draw. In the four traditional schools the principal was said to see himself as the ' boss ' and to be seen by all with whom he interacts as the boss. The network of relationships anchored on the schools were very much controlled by him. In a very real sense they were the gatekeepers of their schools, acting as the communication link with the state education department, deciding who should enter the school and controlling the membership, agenda and activity of the school council—the one formal link with the neighbourhood. These councils are thus very ' tame ' links, and their members are described as being unclear about their role and showing little initiative towards their school. The teachers in these schools saw themselves as the professional experts and expressed strong views against the involvement of parents in decision-making. The parents, for their part, had no wish to become involved. Seeing themselves as ingorant in educational matters and feeling very uncertain about modern methods and educational practices they felt inadequate to play any meaningful role in school decision-making and hence had no aspirations in that direction.

At the same time as the authors make these generalisations about the four traditional schools, they quote evidence of the way in which the principal at one of the traditional schools had succeeded in encouraging parents to attend school functions, of the keen interest the members of the advisory council took in school policy and the resentment some parents expressed about the teachers' reluctance to listen to the parents' point of view about some recent curriculum innovation. One community organisation was also reported as having taken the initiative in securing representation on the advisory council. The researchers suggest, in terms of their framework, that these differences may be due to the entrepreneurial nature of the local economy which would be likely to promote feelings of independence amongst the parents. They also, however, quote evidence of the open, friendly administrative style of the principal of the school, and the contribution he made to curricular innovation in this school. He was also observed explaining and justifying processes and procedures operating in his school to groups and individuals both within and outside the school. In other schools these would be regarded as taken-for-granted day-to-day routines. In such activities, the respect and affection with which he was held were no doubt important factors. What would seem important, however, is the effect such activities could be said to have on the understanding and definition of the school that the others held.

In relation to such activities, it is doubtful if the conceptual framework is adequate. Is that principal merely an actor responding to structural and ideological pressures? Might he he not be regarded as a person with some measure of autonomy, conscious of the complexity of the situation in which he finds himself, aware of the definitions of themselves and of their role in school which parents, teachers and students hold, having the social skills to create the kind of social learning opportunities that will encourage these definitions to be modified and to keep possible conflict within manageable and tolerable bounds? Questions arise, too, in relation to the declared inevitability of conflict in schools. It would seem necessary to deal explicitly with the problem of conflict in the conceptual framework, and to consider situations in which it was observed to play a destructive or constructive role.

Such considerations, however, would involve the inclusion of concepts appropriate to an individual level of analysis in the theoretical framework. Nevertheless, this extension would seem a useful one and one which would be consistent with the emphasis already given in the framework to the definition that individuals have of their situation.

The data derived from the newly-created community school would seem to be in line with that suggestion, given that many of the structural and organisational decisions which were taken in the school were consistent with the ideology of participation. For example, the teaching situation was defined to allow a large measure of freedom of choice for students. Students had the right to speak and vote at staff meetings, and amongst the councillors there was a large measure of expertise in various aspects of education and high aspirations of involving themselves in school decision-making, even to the extent of hiring and firing teachers. Yet in the short life of the school, the outcomes proved to be very different from those intended. Teaching and learning in the school reached crisis point and appeals to the principal to intervene were made, staff reacted in a hostile manner when students expressed strong views in staff meetings and retained the power of veto on any decisions made, and many of the councillors became frustrated in their attempts to participate. As a result of these experiences, at the end of the period of study most of the students, teachers, parents and councillors had virtually ceased to participate in the decision-making process.

In the course of their account of these events, the researchers pose many interesting questions. Predictably they make structural recommendations for the future—suggesting the need to allow differences to exist in educational structures and to develop horizontal links in society with the aim of encouraging local participation in school. Unfortunately we will never know what might have happened had they had a different principal, one who had the insights and skills to mediate betweem the ideological formulations about participation on the one hand and the definition of the situation maintained by the actors on the other. This would mean, however, giving less emphasis to sociological forces in the conceptual framework, a price which the authors may be prepared to pay for reducing the gulf between ideology and reality, between schools defined as they ought to be and schools as they are.

DOUGLAS FINLAYSON.

GIBBONS, J. D. (1976). *Nonparametric Methods for Quantitative Analysis.* New York: Holt, Rinehart and Winston, pp. xv + 463, £9·75.

This book presents the material for a course on nonparametric statistics. It assumes practically no statistical knowledge and numeracy only up to substitution into an algebraic expression. A subsidiary aim of the book is as a reference work on nonparametric statistical methods. As such it invites comparision with *Nonparametric Statistics* by S. Siegel, which was first published over twenty years ago, and which has remained the standard text in the field. It is certainly more suitable for a first course in statistics than Siegel would be as it is far more discursive and includes numerous examples for the student to work through.

Gibbons introduces familiar tests in new situations, e.g. the use of the Wilcoxon test for the symmetry of a distribution or the runs test in the up and down case. A chapter is devoted to the Siegel Tukey test for equality of variability of two samples. Since this test was first published in 1960 it does not appear in Siegel's book. Space is devoted to different ' nonparametric ways ' of estimating the confidence limits of such parameters as intervals, medians, scale factors etc. Although this sounds a contradiction in terms it is appropriate that these methods should be outlined along with the tests on which they are based. However, by far the majority of the material is common to both Siegel and Gibbons and in Siegel it is laid out in a way much more suitable for reference.

To sum up, the new book could be used as a course text in nonparametric statistics. If, however, the main emphasis in teaching is to be parametric statistics and students are regarded as able to read up how to apply a nonparametric test for themselves then I would still prefer Siegel.

SIEGEL, S. (1956). *Nonparametric Statistics for the Behavioral Sciences.* McGraw Hill.

R. MACDONALD.

DE GRUIJTER, D. N. M. and VAN DER KAMP, L. J. T. (Eds.) (1976). *Advances in Psychological and Educational Measurement.* London: Wiley, pp. xi + 320, £14·00, $29·00.

The Second International Symposium on Educational Testing, held in Montreux in 1975, brought together some of the most distinguished workers in the area of psychological measurement; the book is a collection of papers presented at the conference. The book is divided into four sections, one devoted to each of Bayesian methods, the measurement of change, generalisability theory, and item-banking.

Jackson provides us with a gentle introduction to Bayesian methodology, which sets the scene for an excellent, though brief, survey of Bayesian methods in educational testing by Novick. Among his examples are applications to two party decision making, academic prediction systems, and models of fair employment practice. Particularly important is his analysis of the contradictions which can arise in naïve implementations of 'equal opportunity' policies in education or employment selection. Papers follow on Bayesian estimation of examine domain scores (Hambleton, Swaminathan, and Algina), on a Bayesian alternative to significance testing (Rouanet, Lépine, and Pelnard-Considère), and on the use of prior probabilities in discriminant analysis (Goodwin and LeBold).

A great deal of effort has been devoted to the study of mental structures which are supposed to be relatively static over time (for instance, in the fields of primary mental abilities, semantic memory, personality). We still know very little about these mental structures in any broad sense; we cannot, for instance, specify the relationship between capacities, needs, social contexts etc. It is clear that problems associated with the study of the processes of change are of a higher order of magnitude than the problems of studying static structure. Should we, therefore, concentrate upon studies of static structure until we have discovered the firm foundations upon which change must be based? Change, of course, is a central concept in education, and cannot be ignored simply because we feel that the time for study may not be ripe. The second section examines the measurement of change, and revisits many of the classic problems.

The highlight of the section is Roskam's attack on those (many) who seek solutions by mere data manipulation, without a proper conceptualisation of what change is, or why we wish to measure it. Bock explores model fitting for growth curves; Fischer develops a Rasch-style formulation of the problem; papers by Jöreskog and Sörbom, and Sörbom offer models and analyses derived from the current growth area of 'structured covariance.' (Studies of structured covariance use a kind of advanced factor analysis and path analysis which has strong hypothesis testing properties.)

Van der Kamp introduces generalisability theory, and reviews its impact on our notions of test reliability, and of the appropriate design for experiments. Cronbach emphasises the need to integrate decision theory into generalisability theory in order to answer a number of practical questions in educational measurement. Sub-themes are illustrated in papers by Cardinet, Tourneur and Allal, by de Gruijter, and by Hill.

The fourth section further illuminates generalisability theory through five papers on the theme of item-banking, and matrix sampling of item-banks. Papers by Choppin and by Wood are notable, amongst other things, for the attention given to the Rasch model, which usually received scant attention outside continental Europe.

Overall, the book provides a stimulating, but untidy, collection of papers. The editing appears to have been minimal; several contributions should have shown a clear benefit from the interactions and discussions that one imagines took place at Montreux. Repetitions occur; failures to engage with the stance of others are evident in several papers. Each section would have benefited from a review chapter, based, perhaps, on discussions at the session, or which simply highlighted common themes, differences, gaps etc. Nevertheless, the overall quality is high. New theoretical ideas and methods usually leak through into applied settings rather slowly. Many of the ideas raised in this volume are sufficiently new to be unknown to many researchers—nevertheless, despite the conceptual and mathematical difficulties, we ignore them at our peril.

JIM RIDGWAY.

HICKEY, K. (1976). *Dyslexia. A Language Training Course for Teachers and Learners.* Manual, pp. 238; reading pack; spelling pack; tear-off pad. Designed, printed and published by the author, 3 Montague Road, London S.W.19. £15.

To those of us who have seen Miss Hickey's methods in action at the Dyslexia Institute the publication of this training course is a highly significant event. There is in fact quantitative evidence (which was submitted to the Warnock Committee) of its effectiveness, but these figures, impressive as they are, do not fully bring out the way in which a dyslexic child's life can be transformed if he receives help along the lines which Miss Hickey describes.

The scheme is designed primarily for any dyslexic person of average ability or above, though it could no doubt be adapted for use with slow learners or with non-dyslexic pupils who are backward at reading and spelling for miscellaneous other reasons. If, as seems likely, dyslexia involves some kind of limitation in immediate memory load, then methods which are suitable for dyslexic pupils may well help non-dyslexic pupils; but if the demands on memory for detail are too great (as in the ' look-and-say ' method) the converse will not hold.

The programme consists of a series of explanatory chapters, a set of materials to be worked through, a reading pack and spelling pack for systematic practising of sound-letter correspondence, and a tear-off pad for practising handwriting. Although she has not followed her American predecessors uncritically, Miss Hickey lays special emphasis, like Anna Gillingham and others, on what has been called a ' multisensory ' approach: what she is offering is ' not just another way of teaching reading ' (p. ix), but the pupil is required to interrelate the information arising from the different senses (vision, hearing, kinaesthesia); and the language skills covered by the programme include reading, spelling, handwriting, finding words in a dictionary, and the ability to notice all kinds of interesting features in the English spelling system. There is a clear structure which teacher and pupil need to work through in a systematic way; and there are suggestions for ' self-training ' which may be of particular use when the teacher is attending to another member of the group. There can be no doubt that it is the kind of programme which dyslexic children need.

The Bullock Report asserts that the word ' dyslexia ' does not ' indicate any clearly defined course of treatment ' (section 18.5). Even at the time of publication this remark was singularly ill-informed; and if further refutation is needed this training scheme has certainly supplied it.

My personal inclination would perhaps be to lay less stress than Miss Hickey does on the memorising of hand-movements in writing, and I would have some hesitation in introducing all at once (as her reading pack does) the six different vowel sounds represented by the letter ' a ', since at a later stage one can, for instance, point out the influence of the letter ' w ' on the subsequent vowel, as in *water, want, wash,* etc. These, however, are only minor differences of emphasis and the author in fact wisely gives teachers the chance to use *their own* skills and ingenuity in operating the programme, rather than filling in every detail for them.

At a time when misunderstandings about dyslexia are still surprisingly prevalent, special thanks are due to Miss Hickey for having produced such an informed and authoritative work. While others have *talked* about dyslexia (sometimes unsypathetically), she has provided practical educational help. I am glad to be able to pay public tribute to a great pioneer.

T. R. MILES.

LURIA, A. R. (1976). *Cognitive Development—Its Cultural and Social Foundations.* Translated by Martin Lopez-Morillas and Lynn Solotaroff. Edited by Michael Cole. Cambridge, Mass. & London: Harvard University Press, pp. xviii + 175, £9.40.

This book reports a Russian investigation, completed in 1931-32, of the impact of rapid social and economic change on cognitive processes in adults in Uzbekistan—a then remote and backward region of Soviet Central Asia which possessed an ancient Islamic cotton-growing culture and its own language. Luria and his colleagues sought evidence for the Marxist-Leninist thesis that consciousness is the product of socio-historical development, by contrast with the Cartesian emphasis on the primacy of the individual consciousness ('I think, therefore I am.'). This approach raises crucial problems. As Michael Cole remarks in the foreword, the individual's potential for cognitive development may be activated by appropriate circumstances. Nowhere does Luria consider the possible operation of selection or self-selection on the composition of the contrasting groups that he studied.

Luria's method was to give subjects at different levels of educational, social and political development simple tests using clinical interviews reminiscent of Piaget's. A feature of the interviews is the continued probing of subjects' understanding by means of hypothetical opponents (' But one fellow told me . . .'). Sometimes the subjects were seen in groups, and their arguments among themselves served the same purpose. Many areas were investigated including perception, generalisation and abstraction, deduction and inference, reasoning and problem-solving, imagination, self-analysis and self-awareness. Typically results are tabled to show the relative frequencies of various kinds of responses for different groups. The protocols which are included for some of the tasks make the best reading in the book.

Luria's most striking observations show the extent to which the thinking of an illiterate, isolated peasantry, sometimes including cloistered women, is moulded by practical, everyday experience. Almost equally striking, although much more easily overlooked, is the more advanced stage of cognitive development apparent even in subjects with only collective-farm experience or one or two years of schooling. The responses for the more advanced groups sometimes approximated so closely to the typical pattern found elsewhere in Russia (and in the West) that Luria tested relatively few of these subjects.

Had this book appeared in the mid-1930s, shortly after Luria had finished his work, it would have taken its place alongside, say, Vygotsky's *Thought and Langauge*. With its publication delayed for political reasons, even in this more recent text, it risks being dismissed as a curiosity. Nevertheless, this is an enjoyable and at times fascinating book, worthy of its place in the library: of central importance for those interested in cross-cultural studies and worthwile peripheral reading for others. Despite the book's attractively simple and elegant production, not many individual purchasers will want to pay £9·40 for 175 pages; most will wait hopefully for the appearance of a cheap edition.

M. R. MURRAY.

ROWETON, W. E. (Ed.) (1976). *Revitalizing Education Psychology: Readings in Methods and Substance.* Chicago: Nelson-Hall, pp. 390, $15·00.

The title of this work might appear to be presumptuous but very early in the book, after some shrewd comments, a quotation from A. N. Whitehead, arrests the reader, " Some of the major disasters of mankind have been produced by the narrowness of men with a good methodology . . .". Then comes (p. 10) the statement from the editor, " Little is known about the relationship between psychological training and subsequent classroom teacher effectiveness ". By p. 21, P. W. Jackson can draw attention to " a plethora of technically adequate but trivial exercises " which lead him to conclude that, " the major function of research in education is to advance the careers of educational researchers." On p. 329, M. Daniel Smith introduces his contribution with the story of a man who at night came upon another searching for a coin under a street light, After helping in the search for a while, he asked the other if he could recall just where the coin had been dropped. An area in the dark, beyond the fringe of light was indicated. When he remarked that it would be wiser to look there he was told that there was more light for searching under the lamp.

The book is a collection of papers and essays hitherto published by several authors including such well-known names as A. H. Maslow (one of the persons to whom the book is dedicated), Noam Chomsky, Jerome Kagan, Urie Bronfenbrenner, E. R. Hilgard, R. B. McLeod, and R. M. Gagné and is designed as a critical appraisal of the contribution of psychological research to the practical tasks of education. Inevitably, the searchlight focuses upon the methodology and models of explanation in psychology itself and, as may be expected, the paucity of the contribution from much behaviouristically-orientated experimentation is emphasised. By the end of the book the cumulative effect of the many shrewd points made should suffice to dispel any complacency from the professional psychologist, should he have been so misguided as to err in that direction.

Strangely, the enormous contribution deriving from the qualitative study of children's thinking by Binet, Simon, Piaget and the many workers influenced by their approach, which would provide a considerable item on the credit side of the balance sheet, is not accorded the status of a chapter; but the work presents a great deal for a wide range of professional readers and much of it is provocative and salutary.

F. V. SMITH.

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RECENT RESEARCH ON TEACHING: A DREAM, A BELIEF, AND A MODEL

By S. N. BENNETT

(Department of Educational Research, University of Lancaster)

SUMMARY. An attempt is made to provide an interpretive framework for the findings of recent research on teaching at primary school level. A model of teaching/learning processes is outlined prior to an investigation of the empirical linkages between the element of the model. Following this, the implications of the model for teaching skills are explored.

INTRODUCTION

DUNKIN and BIDDLE (1974) introduced their wide-ranging review of research on teaching with a ' dream ' and a ' belief '. Their dream is of an educational system whose procedures are governed by research and by theories that are empirically based, and their belief is that the study of teaching is the heart-land of the research effort which should govern education. They accept that both are arguable propositions and acknowledge the lack of integrating theories concerning teaching. The possible sources of such theories are open to debate. Both Rosenshine and Furst (1971) and Travers (1971) suggest that concepts developed in laboratory settings might provide a starting point, but Nuthall (1968) rejects this. His argument is that " traditional psychological theory cannot be of any significant value until the investigators of classroom behaviour have themselves produced significant theoretical explanations of classroom events. The need is not for further adaptation and stretching of old theory but for the creation of new theory which arises directly from the natural grain and details of the behaviour it is intended to explain." Dunkin and Biddle accept this latter view and argue that the development of explanatory theories will begin as attempts to explain related groups of findings rather than all events concerned with teaching.

There have been few attempts to integrate or explain related groups of findings within an ' interpretive framework ' (Polanyi, 1958). In one recent attempt Nuthall and Snook (1973) identified those conceptual structures which have functioned as models in recent research. Their conclusions were pessimistic. They argued that the current emphasis on observational studies has produced a proliferation of observational systems and frequency counts of the minutiae of teacher and student behaviours in their daily situations. These " show few signs of being any more successful in providing empirical knowledge of value to teachers than the research which has been generated by the major models of teaching ". They do, however, concede that it is possible to conceive of functionally significant models of teaching which do provide appropriate interpretive frameworks.

What is needed, according to Carroll (1963), is a conceptual model of factors affecting success in school learning and of the way they interact. Such a model should use a very small number of simplifying concepts, conceptually independent of one another and referring to phenomena at the same level of discourse. It should suggest new and interesting research questions and aid in the solution of practical educational problems. With the help of such a framework the often conflicting results of different research studies might be seen to fall into a unified pattern.

What follows is the description of a model which might meet these criteria. It is an adaptation of a conceptual model proposed by Harnischfeger and Wiley (1975) for classroom teaching/learning processes. A brief overview is provided prior to an investigation of the empirical linkages between the elements of the model in the light of recent research on teaching in natural settings at primary school level. The second part of the article deals with the implications of this model for teaching skills.

THE MODEL

Harnischfeger and Wiley were clearly influenced by the earlier model of Carroll (1963) and based their model on three strong convictions:

(1) A pupil's activities are central to his learning, the effects of other aspects of the teaching/learning situation being mediated through the pupil's activities.

(2) The total amount of active learning time on a particular instructional topic is *the* most important determinant of pupil achievement on that topic.

(3) There is an enormous variation in time for learning for different pupils, their time devoted to specific learning topics, and their total amount of active learning time.

They dispute the underlying assumption of much research on teaching that teaching behaviour directly influences pupil achievement.

The Harnischfeger/Filey model, modified both in the number and nomenclature of elements, is shown in figure 1.

Quantity of schooling is the total amount of time that the school is open for its stated purpose and is defined by the length of school day and school year. The nominal amount may not be the actual amount since the school may be closed for a number of reasons—extra holidays, teacher strikes, or building alterations. The actual amount will also be reduced for a particular pupil by his absences. This time is allocated to various curricular activities—curricular used here in its broadest sense to include administration and transition time between activities as well as time devoted to content. The curriculum emphasis or balance achieved varies from school to school and from class to class. This element is termed ' time allocated to curriculum activities '. The amount of time allocated to a given curriculum activity is, however, unlikely to match the actual amount of time a pupil will spend on it. Disruptions, distractions, lack of interest in the task or poor persistence are all factors likely to reduce the use a pupil makes of the opportunity to study a given content.

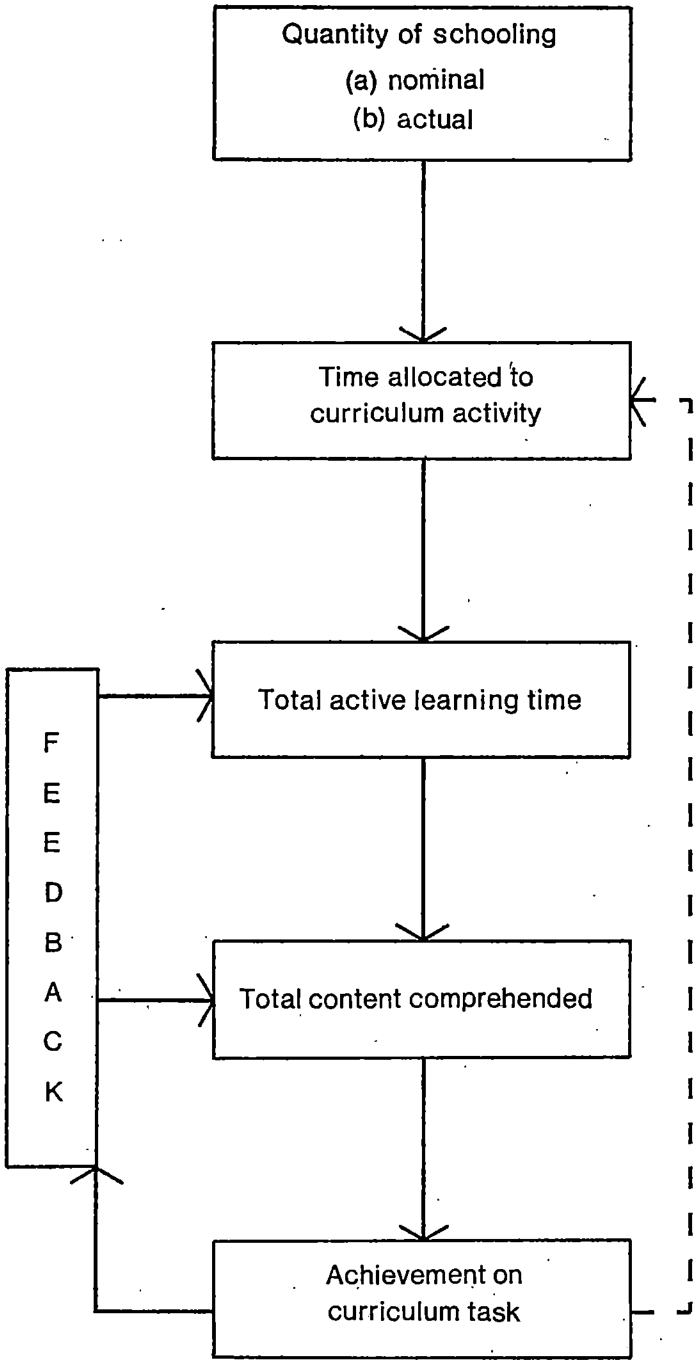
The next element, termed ' total active learning time ', acknowledges this. The underlying assumption here is that only the active portion of the time assigned to a task is effective for learning that task. But whether this active portion is relevant to achievement will depend upon a number of other variables subsumed under ' total content comprehended '. According to this model, time relevant to achievement is mediated by a number of factors including the aptitude and prior achievement of the pupil, clarity of instructions, task difficulty and pacing. Thus only that portion of time during which a pupil is actually comprehending the task is effective for its acquisition, and thus has a direct link to achievement on that task. The additional element, not included in the original model, is feedback, since feedback is assumed to influence comprehension and thereby achievement.

Quantity of Schooling

The exposure of pupils to schooling depends in the first instance on the nominal quantity of schooling defined by length of school day and school year. These would seem to vary widely. A survey by Wiley (1973) in the United States confirmed Mann's (1928) earlier finding that " there was, and is, tremendous variation in a pupil's school day length ", and this has since been supported by Stallings (1975) who found, in an American study, that the length of school day varied as much as two hours per day between schools. Similar data are not available in Britain although one indication of discrepancy can be gained from Hilsum and Cane (1971). Their study was limited to one county but it was found that the length of the school day varied between 375 and

FIGURE 1

Model Relating Pupil Activities to Achievement


Quantity of schooling
(a) nominal
(b) actual
Time allocated to curriculum activity
Total active learning time
Total content comprehended
Achievement on curriculum task
FEEDBACK

430 minutes. Thus, at the extremes, some children were exposed to learning for some four and a half hours a week more than others. Over a 40-week school year the difference amounts to five and a half weeks. These differences appear to be related to discrepancies in policy within the area offices of the local education authority, head teacher decisions and school transport facilities. In the wider setting such discrepancies are likely to be increased by such current events as schools closing for structural repairs, teachers working to rule in selective areas, use of schools as polling stations, and extra holidays. The actual quantity of schooling is therefore very likely to be lower and differentially lower than the nominal quantity. The actual amount of schooling for any given pupil will be lower still when absences from school are taken into account.

The importance of such differences can be assessed from a number of studies which have examined the link between quantity of schooling and achievement. Stallings (1975) found that the length of school day was one of the variables strongly correlated with achievement in both reading and mathematics in her evaluation of 150 follow-through classes. " Out of a possible 340 correlations between reading achievement and classroom processes, 118 were significantly related at the ·05 level. Of these, the most strongly correlated variables suggest that length of school day and the average time a child spent engaged in a reading activity were related to high reading skills in the first and third grade." This same pattern was found for achievement in mathematics.

Wiley and Harnischfeger (1974) adopted an indirect approach and related the average number of hours of schooling pupils received, derived from average daily attendance figures, length of school day and school year, to achievement in verbal ability, reading comprehension and mathematics and found clear, positive relationships. Further, studies which had related teacher and pupil absences to achievement have reported negative relationships (Harris and Serwer, 1966; Bond and Dykstra, 1967; Harris *et al.*, 1968). The latest study on pupil absence (Fogelman, 1978) used data from the National Child Development Study to examine the relationship between school attendance at the age of 7 and 15, and reading and mathematics scores and school behaviour at 16. The relationships between attendance and achievement were clear and statistically significant: " Children with high attendance levels obtain on average higher scores on tests of reading, comprehension and mathematics." Neither was there any evidence that these relationships differ by social class. There was also a slight, but insignificant, relationship between attendance at age 7 and achievement at 16.

Time allocation to curriculum activity

Within the constraints of the actual amount of schooling available the teacher subdivides the time by curriculum area, and plans and implements corresponding allocation of pupil time either in class, group or individual activities. The curriculum emphasis in primary classrooms is often determined by the class teacher, mediated by school policy, attitudes, aims and priorities which have been based on perceptions of the needs of the children and their levels of achievement. The lack of central control of curriculum in Britain is reflected in the large variations found in curriculum emphasis. Some evidence for this was acquired from a questionnaire survey completed by third and fourth year junior teachers in 871 schools in Lancashire and Cumbria (Bennett, 1976) in which teachers were asked to give details of the amount of time spent on all curriculum activities during the week immediately prior to completing the questionnaire. The amount of time spent on English and mathematics varied from 1½ to 8 hours per week.

Ashton *et al.* (1975) also gained questionnaire data on this aspect from a sample of 68 junior head teachers. The most striking feature of these responses was the wide discrepancy in time allocation to different curriculum areas within the various schools.

" The range of 15 per cent to 53 per cent of time spent on language, for example, is remarkable . . . it may be convenient to remember that, equating one week to 100 per cent of time 1 per cent equals just about a quarter of an hour. Thus, in practical terms the time spent on language in different schools varied from something like 3¾ hours of the week to 13¾ hours per week."

Head teacher estimates may not of course be accurate. But evidence from a recent interview study of 893 teachers in Nottinghamshire (Bassey, 1977) supports the general pattern. For example, time devoted to mathematics in junior classrooms varied from less than an hour up to 8 hours per week, and in language from less than an hour up to 10 hours per week. Curriculum content also varied widely, 60 per cent of teachers included more than eight activities in their curriculum, 29 per cent included six or seven and 9 per cent included five or fewer. Wide differences were also apparent in infant classrooms.

An interesting, but little discussed, aspect of allocation relates to flexibility of time slots. Ashton *et al.* (1975) felt that this was a real and fundamental difference between teachers' approaches. The pattern of responses of head teachers with regard to time flexibility in mathematics was fairly typical. 20 per cent thought that there should be one regular, preferably daily, mathematics period, no more, no less. 30 per cent thought that there should be a regular period but that more time could be spent freely. Nearly 40 per cent did not advocate a regular time, indicating that time could be used flexibly provided a long-term balance was achieved. This might mean, in extreme cases, that mathematics need not be taught at all for several days, as long as there was subsequently an intensive session. Finally, just under 10 per cent gave no time allocation to mathematics, advocating that as much or as little time be spent as circumstances directed. Bassey (1977) questioned teachers on this aspect and also found wide variations. Some 50 to 60 per cent of infant teachers thought that children should do some mathematics each day. 20 per cent stated four days in every five was sufficient, and another 20 per cent felt that a regular but not daily requirement was sufficient. 5 per cent said no regular commitment was necessary, but that time was allocated as and when appropriate. When asked the question, " How long do you expect children to spend on mathematics each day? " teachers of older infants also differed in their answers. 3 per cent felt that up to 15 minutes per day was sufficient, 42 per cent said 15-30 minutes, 38 per cent claimed 30-45 minutes and 5 per cent answered more than 45 minutes.

Observational studies provide more precise figures. Filby *et al.* (1977) investigated time allocated to mathematics and reading in six second and fifth grade classrooms. The average number of minutes allocated to reading activities and mathematics varied from 61 to 109 minutes and from 24 to 49 minutes respectively. There were also interesting variations in topics studied in these subjects; some teachers placed heavy emphasis on basic computation where others did not. It was also clear that time allocation varied for pupils within the same classroom.

There is thus much evidence to indicate wide variations in time allocated to basic skills. There is yet little evidence to link allocated time to achievement, although Fisher *et al.* (1977) concluded their study as follows: " This study provides qualified support for the hypothesis that more time yields more learning. This suggests that differences in the amount of time provided for instruction in a given area (either among classes or among students in the same class) are related to the amount learned. Thus, the pattern of time allocation to various subject matter areas and sub areas is an important consideration when planning and implementing instruction."

Total active learning time

Total active learning time can be conceived as the use the pupil makes of the opportunity to study a given content, and here too there is evidence of wide variation.

After establishing allocations of time, Filby *et al.* observed pupils over a seven-day period to establish ‘ engagement rates ’, or the percentage of allocated time the pupils actually spent on-task. These averaged 50 per cent but showed variations from 37 to 74 per cent. The within-class variations were even more marked, from 20-29 per cent to 90-100 per cent.

In an earlier study Gump (1971) reported similar variations in six third grade classrooms and was particularly concerned about large differences in time on procedural activities. These, he reasoned, represent educational losses since they do not directly advance any curricular goal; they are no more than preparations or conclusions. Procedure accounted for as much as 16 per cent of the school day in these classrooms.

There have been few studies of this type in Britain, and most of these are unpublished. Two case studies were carried out using identical observation instruments allowing a direct comparison of two top junior units (Alderson and Hird, 1973; Dennison, 1976). The six most frequent activities of pupils in School A and School B were as follows.

School A	Per cent	*School B*	Per cent
1. Group organisation of work	18·7	1. Mathematics	21·6
2. Mathematics	10·0	2. Reading as a skill	13·6
3. Creative picture making	7·5	3. Topic work	12·6
4. Factual writing	5·7	4. Singing	8·3
5. Creative writing	5·5	5. Comprehension and grammar Reading (general) Listening to a story	4·9
6. Nothing in particular	4·8		

Pupils in School B were engaged on mathematics twice as often as those in School A and in reading 20 times as much. Group organisation of work is akin to Gump's ‘ procedural ’ category and takes up nearly one fifth of the total time in School A.

In the only published study in Britain, Boydell (1975) found that average task involvement in six informal junior classrooms was 67 per cent although this included routine work such as sharpening of pencils. It was also limited to mathematics lessons and included no transition time. There appears to be no evidence of differences of engagement in different subject areas although such data are currently being gathered (Bennett *et al.*, ongoing).

There would seem to be support for the view that quantity of schooling, curriculum emphasis in terms of allocated time, and pupil engagement rates vary considerably. But the crucial question is whether these variations affect achievement. In a recent review of mathemagenic behaviours Faw and Waller (1976) criticise researchers for their lack of concern for study time, arguing that variations in time are of considerable importance. They concluded: “ It can safely be said that effects of study time on performance are large enough to demand our research attention but not so large that nothing else of importance remains to be understood . . . our contention is not that time is the complete explanation of all observed test differences . . . it is simply being maintained that in the absence of clear evidence that different procedures are in fact associated with different treatments, time differences potentially and parsimoniously account for much of the observed data and hence demand serious consideration by all researchers.” More consideration of these relationships has in fact been devoted to this topic than Faw and Waller would indicate.

The most direct evidence emanates from research on mastery learning, an approach based on the premise that, given sufficient time on a curriculum task, almost all pupils can achieve mastery of that task. Block and Burns (1976) have reviewed this research and conclude that “ the greater the elapsed study time and the greater the proportion of that time that is actually spent in learning the greater the achievement." These authors argue that it is the quantity (allocated time) and quality (on-task time) that ultimately affect achievement, a view supported by Fisher *et al.* (1977) in the most recent study in this area. They used the same sample as Filby *et al.*, testing the pupils for achievement in mathematics and reading over an eight-week period. Their findings indicated that where students spent more time on reading, their levels of achievement in it were higher. This applied in general and also within any given class. In mathematics the results were similar. As might be expected, when differences in active learning time were small no strong relationships were recorded, but when larger differences occurred, a relatively strong relationship between active learning time and achievement was found. This study related both allocated and engaged time to achievement and found that the latter was stronger. Such findings tie in with the pattern derived from a review of 20 studies by David (1974) which showed that, in those studies where the variation in exposure to learning was large, consistent positive relationships were gained, but where variation was minimal no consistent effects appeared.

These findings are in accord with much larger observational studies. Stallings and Kaskowitz (1974) related time spent involved in reading and mathematics, and found correlations with achievement ranging from 0·3 to 0·6. Brophy and Evertson (1976) report that, across a two-year period, ratings of student engagement show strong and consistent positive relationships with learning gains. Similarly, in his review of studies in this area, Bloom (1977) found that correlations of attention with gain were about 0·4 when the student was the unit of analysis and 0·5 when the class was the unit.

This link between work activity and achievement would not appear to be dependent on age. Studies by Samuels and Turnure (1974) among 6-year-olds, by McKinney *et al.* (1975) among 8-year-olds, by Cobb (1972) among 11-year-olds and by Lahaderne (1968) among 12-year-olds, all demonstrate positive relationships. McDonald (1975) also demonstrated the obverse—that pupil inattentiveness is negatively related to achievement. Although concerned with post-primary age levels, it is interesting to note that Postlethwaite (1975), in considering the implications of the IEA surveys of achievement, named time and opportunity to learn as the most important factors to emanate from the study (cf. Dahllof, 1971).

This evidence would indicate that the engaged time/achievement link is valid for all ages of compulsory schooling and lends force to Walker's (1976) hope that " the next decade will see as much attention to what students do in classrooms as has been paid in the past decade to what teachers do ".

Comprehension

At this point it is important to return to Faw and Waller's contention that time spent in learning is by no means the *complete* explanation of differences in achievement. A large amount of time spent on incomprehensible content is not likely to lead to learning, a point made by Carroll (1963) in the original exposition of his model of school learning. In this he indicated four or five major variables which would also affect pupil comprehension—pupil aptitude, clarity of instruction, sequence, level and pace of content. All but the first are subsumed under his category of quality of instruction.

Rosenshine (1971) has reported positive relationships between ratings of clarity and achievement, but only a questionnaire study by Bush *et al.* (1977) which indicated that ' clarity ' can be assessed objectively, has extended this formulation. Even less evidence is available from research undertaken in natural settings on sequence, level and pace. Despite divergent empirical findings, sequencing has continued to be regarded as central by instructional theorists such as Ausubel and Gagné. Ausubel (1963), for example, has stated that "of all the possible conditions that affect cognitive structure, it is self-evident that none can be more significant than the internal logic and organisation of the material ". Unfortunately it is difficult to define clearly what is meant by ' logically organised sequences ' and, in their review of this area, Posner and Strike (1976) argue that despite long debates on the issue, no satisfactory answer has been found and no adequate prescription is to be expected in the near future. They concluded: " We have very little information based on hard data regarding the consequences of alternative content sequences and will need a good deal more research effort before we are able to satisfactorily report how the content should be sequenced." Tennyson and Tennyson (1977) agree that no prescriptions are possible but cite evidence to indicate that content structure can make a difference in terms of performance and rate of acquisition in learning concepts (Houtz *et al.*, 1973; Tennyson, 1973).

Lack of adequate evidence has not deterred the development of approaches which adopt a sequenced approach. Mastery learning is one such example, but it is interesting to note that the component of mastery learning which has the greatest effect is not sequence, but the unit mastery requirement (Block and Burns, 1976). The more stringent the requirement and its enforcement, the better and more similarly have students studied and learned, i.e. the higher the unit mastery requirement the greater the quantity of elapsed time spent studying and the greater the proportion of that time spent actually engaged in learning. This premise that greater learning occurs when expectations are higher is supported by an observational study by Good *et al.* (1977) who found over an 80-day period that teachers in classrooms which showed high mathematics achievement averaged 1·1 page of text book coverage per day while teachers in classrooms which showed low mathematics achievement covered only 0·7 pages per day. It is not clear whether allocated time was kept constant in this study. If it was, this would indicate that teachers make different use of the same time. Pidgeon's (1970) large scale comparative study of 3000 English and 3000 Californian pupils is of interest in this context. Differences in scores on mathematics tests were extremely large. For example, 1000 English pupils scored above 38 on the 70-item test, whereas only 53 Californian pupils did so. These differences were interpreted in terms of different requirements or expectations. " In California much less was expected of pupils in arithmetic, more limited objectives were formulated for children of primary school age and less emphasis was placed on rapid progress in mechanical arithmetic than was customary in England and Wales."

In mastery learning approaches, the level and pace of instruction is oriented to the individual learner, a situation not likely to be found in all classrooms. In one of the few studies carried out in natural settings that throws light on such relationships, Brophy and Evertson (1976) reasoned that learning will be optimal when presented at the optimal difficulty level since, if the content is too easy or too hard learning will be less than optimal. On the basis of their two-year study they concluded: " Low SES children (and by implication, less competent children of any SES level, compared to more competent children in the same class) learn more by having less taught to them, and by having it taught to them redundantly to the point of over-learning, proceeding in small steps that they can master without undue cognitive strain. In contrast, somewhat more competent children can cover the same material more quickly and furthermore will learn more optimally by being challenged with slightly more difficult questions and assignments." In low SES classrooms observer ratings of assignment difficulty correlated negatively with learning gains whereas in high SES classrooms ratings of assignments as too easy correlated negatively with learning gains. SES as used in this study was a proxy measure for ability, knowledge and motivation.

Research in the field of reading is also relevant in this context. Bond and Tinker (1973), for example, argue that failure to adjust the material and the instruction to the range of reading capabilities found within the classroom is probably the most important single cause of reading disability. But despite such assertions it would seem clear that in the United States, where most of this research has been carried out, such matching is far from ideal in the actual classroom situation (Zintz, 1975; Jones, 1948; Chall and Feldmann, 1966; Kelly, 1970; Jorgenson, 1977). Additional evidence on such relationships is reviewed by Cronbach and Snow (1977).

Research on the factors included within the ' Total Comprehended ' category in Figure 1 is limited in the natural classroom setting. Nevertheless the evidence is fairly consistent in indicating that these factors do have an effect on learning outcomes and that interactions can be expected with both pupil aptitude and personality characteristics.

Feedback

The category of ' feedback ' is strangely absent from the models of Carroll and of Harnischfeger and Wiley, despite the fact that there has been much research on instruction on the role of feedback in students' learning. Kulhavy (1977), who is critical of the view that feedback simply acts as reinforcement, argues that what feedback does is simple. " It confirms correct responses, telling the student how well the content is being understood, and it identifies and corrects errors, or allows the learner to correct them. This correction function is probably the most important aspect of feedback, and, if one were given the choice, feedback following wrong responses probably has the greatest positive effect."

The effectiveness of the correction function can be shown in recent classroom research. Brophy and Evertson (1976) found, particularly for low SES pupils, that opportunities for immediate practice of the skills, together with opportunity for immediate corrective feedback were very important. " Thus, the most successful teachers, in terms of pupils' gains, conducted group lessons by giving initial demonstrations and then quickly moving around having each student try out what has been demonstrated and providing feedback on an individual basis." Soar (1973) found similar effects with low SES children. In his study structured teaching was the most successful approach, an integral part of which was immediate feedback to pupils on the correctness of their responses.

Stallings and Kaskowitz (1974) correlated different types of feedback with learning outcomes. Their results suggested that the topic of feedback (academic, behavioural, other tasks) is more important than type of feedback (positive, negative, neutral). When the topic of feedback was academic, i.e. reading and mathematics, 19 of the 20 correlations were positive, 13 of them significant, and this held whether the type of feedback was positive or negative. When the feedback related to other tasks (music, art, dance, science) the correlation was almost always negative with regard to the outcome measures regardless of type of feedback. Earlier reviews have tended to show negative feedback or criticism as being negatively related to achievement. The Stallings and Kaskowitz findings go against this as do those of Brophy and Evertson who found an interaction with SES level. They found that in general the most successful teacher of low SES pupils motivated them primarily through gentle and positive encouragement and praise while the most successful high SES teachers motivated through challenge and critical demands which involved communicating high expectations and criticising their pupils for failing to meet them. In both years of the study, praise tended to correlate negatively with learning gains in high SES pupils and positively with gains in low SES pupils. A discrepancy was also noted in type of praise in pupil-initiated and teacher-initiated interaction, the praise in the latter context being more credible. It was also claimed that those children with high achievement motivation and a successful record of achievement (which corresponds roughly with their definition of high SES) respond better to criticism than praise.

Symbolic as well as verbal feedback would seem to be effective. Brophy and Evertson found that the use of symbolic rewards such as gold stars and " smiling faces placed upon papers to be taken home and shown to the parents, or placed on charts in a room, showed consistent positive association with learning gains ". Classroom based experiments on material incentives supports their efficacy (Benowitz and Busse, 1970; Benowitz and Rosenfeld, 1973; McMillan, 1973). Benowitz and Busse (1976) recently extended these small-scale studies to investigate the effectiveness of continuous use of material incentives in normal classrooms using typical instructional materials, and found not only did they improve achievement over the four-week period but the effect was stronger at the end of the experiment than at the beginning. Such incentive may however be more effective for some types of pupils than others.

Summary

On the basis of the evidence currently available it would seem that the elements of the model have empirical support. Nevertheless more research is clearly needed. Many of the studies which bear directly on the verification of the model have been limited in size and achievement criteria. Much of the evidence is based on the reading and mathematics achievement of predominantly low SES pupils, although the definition of SES in these studies varies. Such studies leave unanswered the wider applicability of the model to curriculum areas such as music, art or social studies. Little is yet known about optimal time allocations or engagement rates and whether these vary in relation to pupil characteristics. No research has yet been undertaken to assess the amount of achievement variance accounted for by the elements in the model. These are but few of the new and interesting research questions suggested by the model. But no model of the teaching/learning process would be of value unless it allowed implications for teaching skills to be inferred. It is these implications which are now considered.

IMPLICATIONS FOR TEACHING SKILLS

Time allocation

A consideration of time allocation leads to implications for curriculum planning. The evidence indicates that the knowledge the pupil acquires depends on the coverage and emphasis on the curriculum adopted. This evidence, together with that drawn from the field of curriculum evaluation (cf. Walker and Scaffarzick, 1974) indicates that, other things being equal, one curriculum is intrinsically neither better nor worse than another, rather that different curricula result in different patterns of knowledge acquisition (Berliner and Rosenshine, 1976). The primary teacher who in Britain has considerable influence on curriculum emphasis is thus faced with a set of critical questions. Should the emphasis be on the development of the basic subjects, or should there be equal concern with creative expression and aesthetic appreciation? How much time should be devoted to each? Should equal time for leaving be allocated to pupils irrespective of ability or previous achievement? Such decisions by individual teachers would result in quite diverse emphases and balance even within a given school.

The basis on which such decisions are made deserves a study in its own right but, in the absence of direct evidence, it would be expected that such decisions are mediated by aims, and Ashton *et al.* (1975) have shown that there is little consensus about aims at the primary level. Some teachers stress academic aims such as the development of competence in the basic skills and a high level of academic achievement. Others stress social and emotional aims, feeling the happiness and well-being of the pupil are most important. Others attempt to stress both. Indirect evidence on the link between aims and decision making is provided by both Ashton *et al.* and Bennett (1976) who found moderately strong relationships between aims and teaching approach. Those who stressed social and emotional goals placed less emphasis on basic skills and more on aesthetic and creative activities. They also tended to teach informally. Those who stressed academic goals devoted more time to basic skills and tended to teach formally. On this evidence it would appear that, in general, aims are reflected in practice, although it is not clear whether teachers are aware of the implications of such practice. Clearly, teachers and student teachers should have, or be given, the necessary knowledge and conceptual skills to think clearly and critically about aims and their relation to practice and possible outcomes.

Aims may, as suggested above, relate to time allocation in terms of general curriculum balance. But a further, and equally crucial, decision to be taken by teachers is how to allocate time within content area. Anderson (1976) has demonstrated that an equal amount of time for learning given to each pupil will not produce equal learning. Atkinson (1976) spells this out more clearly by asking whether it is the objective of the teacher to (*a*) maximise the mean achievement of the class, (*b*) minimise the variation in learning within the class, or (*c*) maximise the mean without further magnifying the differences among pupils. He maintains that any of these can be achieved by the manipulation of time allocation. To achieve (*a*), the higher achievers are given more time, allowing them to progress far beyond the slower learners and thus maximising the differences between pupils. To achieve (*b*), time allocation is reduced for higher achievers and more time devoted to the slower learners. To achieve (*c*), which he maintains is preferred by most educators, time allowed for faster learners is manipulated to ensure that initial differences between fast and slow children are maintained. Doyle (1977) discusses some of the strategies used by teachers which effectively bring this about. Whatever the decision on the part of the teacher there are clearly both pedagogic and ethical considerations involved.

Another form of time allocation open to manipulation is increasing actual quantity of schooling by setting homework, a practice not currently widespread at primary level. The reason for this is not clear. The Plowden Report (1967) did not discourage it, stating that " homework should be a matter for discussion and agreement between home and school and that the school should give thought to the form of homework most suitable to children's varying circumstances ". There has been little research on the topic although the IEA study on mathematics (Husen, 1967) found moderate positive relationships between homework and mathematics achievement. This would suggest a rethinking of the possibilities of homework, possibly utilising it in a remedial role.

Actual quantity of schooling is often decreased by pupil absence. It follows from the evidence that this is likely to depress achievement. The studies so far carried out do not appear to have taken into account the length of absence, or what strategies teachers employed to combat such absence. The relationship between absence and achievement is also likely to be mediated by teaching approach. Stallings and Kaskowitz (1974) reported that although direct teaching was associated with greater pupil gains in learning, the open or informal approaches were associated with less pupil absence. In other words open approaches achieve less even though pupils are in school longer. Nevertheless the implication is that teachers should attempt to compensate for pupil absence. Strategies which could be used would include personal tutoring or increased time allocation both within and without the classroom.

Active learning time

Although allocated time and active learning time are related to achievement, active learning time shows the greatest effect. It has also been shown that engagement rates differ markedly both within and between classrooms, and that they also interact with pupil characteristics. They may also vary by content area. The implications from the evidence on active learning time are primarily to be found in the area of classroom management. The work of Kounin (1970) is of seminal interest here since he traced relationships between teacher behaviours and pupil involvement in work, which varied according to the learning context. The most salient teacher behaviours in maintaining involvement in class teaching situations were ' with-it-ness '—an awareness of monitoring events in the classroom regardless of her current activity; ' smoothness '—teacher behaviours which maintained a smooth flow of classroom activities particularly at points of transition; ' momentum '—freedom from slow downs; ' group alerting '—maintaining attention to non-responding pupils, and ' overlappingness '—the teacher's ability to deal with two or more things at the same time. In group work situations the above behaviour is again related to work involvement, but the strongest relationship found was with ' variety and challenge '—giving pupils varied tasks to do.

Despite the somewhat eccentric terminology, Kounin's research has been widely accepted by classroom researchers. Dunkin and Biddle (1974) commented that " considerable improvement in classroom teaching could be wrought by alerting teachers to Kounin's major concepts and findings ". Nevertheless they had reservations about the inter-dependence of teacher behaviour so categorised, and the lack of validating evidence from process/product studies. The Brophy and Evertson study is important in this respect since, in a process/product investigation, the variables discussed by Kounin were measured with both high and low inference observation instruments. Of all the process measures used, Kounin's dimensions had the strongest and most consistent relationships with student gains. They reported that their most successful managers were ' with-it ', spotting possibly disruptive behaviour early and dealing with it appropriately and calmly. This quality was also related to increased learning gains, the reason being " obvious: teachers who have few discipline problems therefore have most of their time available for teaching and are more likely to teach successfully compared to teachers who spend significant amounts of time fighting for attention or trying to deal with severe disruptions and discipline problems " (Brophy and Evertson, 1976). They found that ' smoothness ' showed up in the automatic ways that successful managers operated through effective monitor systems and classroom rules. This was particularly obvious during transitional periods between activities. In well-organised classrooms transitions lasted only a short time and the children seemed to transfer to another activity automatically. By contrast, transitional periods in less well-organised classrooms tended to be chaotic, with children wandering about, bumping into one another, being confused and needing to ask the teacher what to do next. Brophy and Evertson concluded that " student engagement in lessons and activities was the key to successful classroom management. Successful teachers ran smooth, well-paced lessons with few interruptions and their students were consistently at their seat work . . . it was clear that the seat work of the more successful teachers was more individualised and more appropriate for each particular student." Although these general principles held, there were some differences in what was optimal in high and low SES classrooms. The high SES children were more capable of assuming independent responsibility and of exercising choice of assignment and working independently, and these privileges were allowed by more successful teachers. On the other hand, the more successful teachers in low SES classrooms were more restrictive and provided more structure.

In the only British study to adopt Kounin's approach, Law (1977), after studying a limited number of infant and junior classrooms, concluded: " One of the major results to emerge . . . is that infant teachers are generally higher, not only on praise, but on all positively scored managerial techniques . . . the trend is that the more teachers manage, the higher the work involvement of their pupils." Law surmised that this pattern is, in part, related to the organisational patterns employed in infant classrooms, a notion that is congruent with the later work of Kounin and his co-workers. Kounin and Gump (1974), for example, delineated dimensions of formal lesson formats that were associated with task related behaviour of children in those lessons. They conceptualised lessons as providing signal systems to their participants, and characterised them as varying along three dimensions—' continuity ', ' insulation ', and ' intrusiveness '. They then demonstrated that lessons categorised in these terms could be associated with the amount of task involvement of participating pupils. Kounin and Doyle (1975) focused on ' continuity ', hypothesising that the more continuous and unlagging the provisions of a lesson, the greater the pupil's involvement in the task. (' Provisions ' include communications of the teacher, the props that go with the lesson and the regular behaviour patterns, e.g. listening to a story.) Where the teacher maintains a high level of continuity there is a continuous flow of information to the pupils which allows them to maintain high task involvement and to avoid deviance or inappropriate behaviour. In contrast, if the children have to rely on other pupils as sources of information, as in discussion, these sources are likely to be inadequate, leading to faltering continuity and relatively high off-task behaviour. The Kounin and Doyle study also demonstrates that ' continuity ' within lesson types distinguished between those lessons that had high and low task involvement when managed by the same teachers.

This concept of the continuity of information flow throughout a lesson could be used to explain why such categories as ' smoothness ' and ' momentum ' are correlated with task involvement in class teaching situations. These teacher behaviours help to maintain continuity in such settings.

The ethnographic studies of student teachers by Doyle (1977) on the relations between environment and behaviour could provide a useful basis for generating hypotheses about the processes involved in learning to use teacher skills in classroom contexts. He maintains that the most salient features of classrooms for students are ' multi-dimensionality '—that classrooms serve a variety of purposes and contain a variety of events and processes not all related and compatible; ' simultaneity '—many of these events occur simultaneously, contributing to ' unpredictability ' in sequences of events. In the folk-lore of teaching adaptation to unpredictability is called ' flexibility '.

Doyle states that all teachers develop a set of responses which function to reduce the subjective complexity of the classroom and that successful strategies tend to incorporate an identifiable set of teaching skills:

(1) Chunking—the ability to group discrete events into larger units.
(2) Differentiation—the ability to discriminate among units in terms of immediate and long-term significance.
(3) Overlap—the ability to handle two or more events at once.
(4) Timing—the ability to monitor and control the duration of events.
(5) Rapid judgment—the ability to interpret events with the minimum of delay.

He suggests that these skills map a part of the tacit knowledge experienced teachers have about the way classrooms work. Chunking, differentiation and rapid judgment form part of the fundamental interpretive competence necessary to negotiate classrooms demands, and overlap and timing supplement these, enabling the regulation of classroom demands. He concludes that the process of understanding the classroom environment involves learning a set of specific strategies for reducing complexity.

Brophy and Evertson commented on the excessive amount of time wasted on transition and this relates to an index of management competence put forward by Gump, this being the notion of ' operating efficiency ' (Gump, 1974). If, as Good, Biddle and Brophy (1975) argue, the secret of successful management is in keeping pupils actively engaged on productive activities, then periods of inactivity or confusion are unproductive. Gump defines his index of operating efficiency as " the percentage of time a school consumes in its non-core, non-substance phases . . . moving, waiting, getting organised periods ". The comparison of School A and School B made earlier indicates that nearly 20 per cent of the day in School A was spent in ' getting organised ' and Gump found similar proportions in his study. In fact in one half day, this category accounted for almost 40 per cent of the elapsed time. He explains some of these delays in terms of teacher preparation activity but " the most common problem was a teacher not ready to start an operation because she was busy closing out a previous one or dealing with a special problem ". Non-substance time was also higher in open plan situations where pupils could be occupying a number of different sites or spaces.

These findings are supported by preliminary findings in the current inquiry into ' open plan ' schools (Bennett *et al.*, ongoing). In observing pupils' days it has been found that transition from one activity to another varies from 3-30 per cent of the units of observation noted. Part of this is due to clearing up after one activity and preparing for another, but a major consideration appears to be the degree of movement from one space to another within the teaching unit. In some teaching organisations teachers and pupils follow each other around spaces, and unless all teachers are equally efficient in clearing up, considerable confusion and delays are inevitable. Although the study by Gump is the only published study on the efficient use of space in open and traditional design schools, it would seem that non-substance or transition time could be higher in open plan buildings under certain forms of teaching organisation.

Another feature of time-wasting in schools is ' queuing '. Delay is one of the four unpublicised features of school life according to Jackson (1968) and although studies of time spent waiting are now being carried out little evidence is available to date. In the open plan study a category of ' waiting for teacher ' is as high as 10 per cent in some instances, and could certainly be included within the index of operating inefficiency.

In his earlier studies Kounin demonstrated that different managerial skills were required for class teaching and group work situations, and later on he suggests that task involvement in group work settings is likely to be lower. This would indicate that, unless competently managed, working in groups could depress achievement. This is an important consideration since one of the significant movements in primary teaching in the last decade or so has been from whole class to small group teaching activities.

Children are often grouped within the class on the basis of similar ability or attainment and the Plowden Report expressed approval of such practices. It claimed that children learned to get along together, to help one another and to realise their own strengths and weaknesses. They make their meanings clearer to themselves by having to explain to others. The report commented on apathetic children affected by the enthusiasm of the group, able children caught in the thrust and counter-thrust of conversation and children gaining the opportunity to discuss and thus understanding more clearly what their problem is. As an ideal this enthusiastic description may be acceptable, but the reality is often very different. A study by Boydell (1975) points to three factors which operate against this ideal. In junior schools girls tend not to talk to boys, and vice versa; only half the talk in groups is concerned with on-going work, and conversation tends to be relatively short. This lack of sustained conversation cast doubts in Boydell's mind about the extent to which children explain and develop their ideas. In visiting schools it is often seen that teachers create groups for organisational rather than pedagogic purposes. Children can often be seen working *in* a group, but rarely *as* a group, and this may be reflected in Boydell's findings. Another observational study at junior level (Morgan, 1975) found that pupils waste more time when not supervised or paced by the teachers. Boys, and particularly bright boys, wasted most time under such circumstances. This same study indicated that pupils in informal classrooms wasted more time than pupils in mixed or traditional classrooms, a finding also reported by Bennett (1976) and by Bell *et al.* (1976).

American studies provide further evidence on the relationships between grouping and achievement. Soar (1973), and Stallings and Kaskowitz (1974) present data showing that, at infant level, teacher-supervised large groups are the best organisation for achievement. Teacher-supervised small groups, pupils working independently or in small groups without a teacher, and self-directed individual or group study all relate negatively with achievement. One explanation put forward is that at this age children are more likely to attend to their task when being supervised. While teachers are with one or two children they are unable to provide sufficient supervision for the remainder. Thus, unless the teacher is very ' with-it ', the use of larger groups allows for more supervision.

It would be reasonable to argue that the value of group work methods lies not in the intellectual domain but in the social. Barnes and Todd (1977), whilst not arguing that small group methods are necessarily a good thing in themselves, feel that skills and competencies not normally manifested in the conventional classroom can be drawn out in groups, and they offer tentative suggestions to teachers on how to organise and structure such groups. These suggestions include considerations such as clarity of purpose, how to structure discussions, and on the type of group to set up. They argue for example that single-sex, self-selected groups with two, three or four members are probably optimal in the secondary school context in which they were working.

Research on the utility and operation of groups in natural classroom settings is rare. The picture which emerges is that group work tends not to be associated with high academic achievement, possibly because of the associated increase in off-task behaviour. There may be benefits to be gained in social and communication skills, but this has yet to be demonstrated empirically. The major problem may be that groups are not explicitly set up for pedagogic purposes and indicates that more thought and research needs to be undertaken on group management skills.

Research undertaken within a different theoretical perspective also has implications for management practice. Studies based on reinforcement theory have tended to be experimental studies of teacher reinforcement schedules using pupil behaviour, rather than achievement, as the dependent variable. In their review of the area Dunkin and Biddle (1974) are very critical of the methodological shortcomings of such research but claim that the findings are consistent. Praise, material incentives, extrinsic tokens, response manipulation and peer manipulation have all been employed to reduce pupil deviance, and material incentives, extrinsic and intrinsic tokens, have been shown to be effective in controlling pupil task involvement.

One of the problems in implementing such an approach is the application of reinforcement schedules to classes of 30 pupils or more in the natural setting, particularly since schedules appropriate to one child may not be appropriate for another. This problem is but one symptom of a much wider disease in research on teaching— the inability of researchers to come to grips with individual differences in the classroom, conceptually or empirically. Cronbach and Snow (1977) recently produced a major review of aptitude/treatment interaction studies and although they reaffirmed their faith that ATIs are elusive rather than illusory, their conclusions were pessimistic. There is for example a large literature on the relationships between personality characteristics and school achievement but very few studies have taken the classroom context into account. Nevertheless consistent findings do emerge on the interaction of teaching approach with anxiety and achievement whereby structured approaches favour the anxious child (Grimes and Allinsmith, 1961; Leith and Bossett, 1967; Minuchin *et al.*, 1969; Trown and Leith, 1975; Bennett, 1976).

Comprehension

Implications emanating from the ' Comprehension ' category are few, not only because of lack of research, but also because of the cautions expressed concerning prescriptions on sequencing. Such reservations tend, however, to relate to considerations of optimal sequencing strategies rather than to disagreements over the efficacy of sequencing *per se*. Curriculum packages are increasingly sequenced and are readily accepted by teachers, as can be seen in the increasing adoption of the ' Fletcher ' mathematics scheme and SRA laboratories. Whether teachers use this strategy in the development of their own curriculum materials (e.g. work cards) is more difficult to say. One factor which may operate against the efficient use of sequencing by the teacher is their knowledge of the content area. Concern is currently being expressed about the lack of expertise or qualification of primary school teachers in the area of mathematics, and King's (1978) remarks concerning the infant teachers' orientation to mathematics as esoteric knowledge is of interest in this context. Unless teachers are thoroughly familiar with content it seems unlikely that effective sequencing can be achieved. The question must also be raised about whether, or how, adequate sequencing is maintained by teachers using project-based approaches.

Here the problem of individual differences is raised again, since the assumptions of most advocates of sequencing is that a single sequence is equally appropriate or effective for all pupils. The lack of research makes such generalisations impossible to justify and it is worth considering the comment of Bruner (1966) that " the fact of individual differences argues for pluralism and for an enlightened opportunism in the materials and methods of instruction . . . no single ideal sequence exists for any group of children ".

The problem of the match between individuals and teaching methods and materials has a long history in the theory of education. But here, as in so many areas, practice does not fit in with theory. The studies carried out so far would indicate that the difficulty of curriculum materials are often not commensurate with the ability or competence of the pupils. Many teachers, it would seem, underestimate the progress that their children are able to make. The studies by Pidgeon (1970) and by Good *et al.* (1975) suggest that these expectations are conveyed through text books and other instructional materials, and yet conventional research on teacher expectancy has been limited to teacher behaviour.

The efficacy of slower pace and small steps for low SES or less able pupils is supported from a number of sources. But the opposite finding for high ability or high SES children creates problems for those teaching mixed ability groups. Such findings also open up the possibility of changes over time. Once the pupil has grasped the fundamentals, a change in pacing and level must become appropriate. Thus, in the words of Brophy and Evertson, " matching instruction to pupils, needs to be an evolutionary, constantly changing, challenging process ".

Possibly because of the lack of relevant research perhaps the most apt conclusion is that written by Carroll in 1963. " The job of the teacher . . . is to organise and present the task to be learned in such a way that the learner can learn it as rapidly and efficiently as he is able. This means first, that the learner must be told, in words that he can understand, what he is to learn and how he is to learn it. It means that the learner must be put into adequate sensory contact with the material to be learned . . . it also means that the elements of the learning task must be presented in such an order and with such detail that . . . every step of the learning is adequately prepared for by the previous step. It may also mean that the instruction must be adapted for the special needs and characteristics of the learner, including his stage of learning."

Feedback

The implications of research on feedback are clear in Kulhavy's (1977) mind. His recommendations for teachers are: " First make sure the learners have appropriate entry skills for the lesson; second, structure the material in such a fashion that the response precedes the feedback in spite of the student. Finally, provide feedback as often as possible during the course of the lesson. If teachers follow these guidelines they should reap the best that feedback has to offer and more importantly their students will have a better chance of learning what is put before them."

Research in natural settings has also attested to the efficacy of immediate feedback and opportunities to practise, but many of these studies have examined praise as the primary mode of feedback rather than diagnostic information. The relationship of praise to achievement is no longer as clear as earlier reviews suggest. To pay off in achievement terms, praise has to (*a*) relate clearly to the topic under consideration, (*b*) be genuine and credible rather than perfunctory and (*c*) be used judiciously in relation to individual differences. There is much evidence to suggest that criticism can be as effective as praise with certain types of pupils.

A gap which exists in this type of research is the quality of the information fed back. An informal assessment of the types of marking in exercise books or work books would indicate that the ' tick, good ' or ' four out of ten ' is still endemic, a practice which is less than useful in feedback terms. McKeachie (1974) for example has argued that the provision of feedback, even if the feedback is given in an informative way, is insufficient for optimal learning. A pupil must also be given some description indicating what he can do to correct unsatisfactory results.

Here the consideration of feedback overlaps with consideration of assessment, both informal and formal. Indications are that teachers are much more familiar with the former than the latter. Indeed many teachers at primary level dismiss formal, and recorded, assessment despite the recent Green Paper's (1977) stress on the necessity of systematic and understandable record-keeping systems. The observation of Alderson and Hird (1973) is not atypical: " All teachers placed greater stress on individual unrecorded assessment. Having the opportunity to get to know a child over a fairly long period made formal recording of progress unnecessary." One of the teachers, Mrs. Carpenter, in the study by Sharp and Green (1975) presents an even more extreme example. In her classroom the largest amount of time was devoted to infant children being allowed and expected to structure their own activities according to their needs and interests. There is therefore, as the authors point out, " no set curriculum for each child to follow and against which the children's progress might be measured and compared ".

Yet it could be argued that in order to ensure continuity of school development across a wide range of curriculum areas formally recorded progress is necessary, particularly in a more informal classroom where groups of children are continually involved in different sets of activities. Such problems are exacerbated in open plan schools which operate team-teaching organisations, since in some of these any member of the team can be responsible for the assessment of any pupil. Many schools are implementing school-based record schemes not only to improve continuity of information within class, but continuity across classes. Such schemes, particularly in the area of mathematics and reading, may be linked with a school-based scheme run by a specialist who sorts out problems that arise and monitors overall progress within the school. In view of the lack of expertise in mathematics of many primary school teachers, this would seem to be an effective way of making maximum use of the expertise available in the school to all teaching staff. The same is likely to be true of reading. The Bullock Report (1975) for example argued that " the school with high standards of reading is the one where the teachers are knowledgeable about it and are united in ascribing to it a very high priority. A coherent strategy understood and agreed by the staff is the best instrument for improving standards of teaching and language."

Feedback is a two-way process as indicated in the model. Assessment of the pupils not only indicates degree of mastery and conversely areas where mastery has not been achieved, it also indicates to the teacher the degree to which she is meeting her aims and objectives. The value of this can be summed up in the words of one headmistress who maintained that assessment and the documentation of assessment in school record keeping systems was kept " in order for us to set further objectives, to improve and redefine our policies ".

Arguments concerning assessment often appear to assume that teachers have the skills necessary to design and administer criterion-referenced assessments. However, many students leaving college have little such knowledge and it could be that their lack of enthusiasm for such assessment is, in part, the result of that lack of knowledge or expertise. A similar argument could be presented regarding the choice of standardised tests, particularly in the area of reading. Many psychologists criticise teachers' use of out-dated and out-moded tests, but here again little advice is provided in many colleges.

CONCLUSION

Dunkin and Biddle's dream of an educational system whose procedures are governed by research and by empirically based theories is still a pipedream. However the first tentative steps have been taken. All models, or ' humble theories ' as Snow (1973) calls them, are limited. Nevertheless the model presented here does meet the criteria set out by Carroll. The elements, at least taken separately, do appear to have been empirically verified, and have the capacity to order disparate findings into a unified pattern and to raise new and interesting questions for future research, while also providing implications for the practice of teaching and teacher-training.

Of the many implications to emanate from this model perhaps the most important in terms of classroom practice is the view of the teacher as manager. Westbury's (1977) definition of teaching summarises this view. " Teaching can in fact be seen as the management of the attention and time of students *vis à vis* the primary educational ends of the classroom." The recognition of teaching as the management of instruction is not new. Currie (1884), for example, wrote: " The art of teaching . . . comprehends all of the means by which the teacher sustains the attention of his class. By attention, we do not mean the mere absence of noise and trifling; or that inert passive state in which the class, with eye fixed on the teacher, it may be, given no symptom of mental life; not that intermittent and almost unconscious attention bestowed on some casual topic which strikes their fancy; not the partial attention given by a few who may be in the immediate neighbourhood of the pupil addressed. The only satisfactory attention is that which is given voluntarily and steadily by all during the entire instruction, and in which the mental attitude of the class is actively engaged along with the teacher in working out their own instruction." Little is new in teaching it would seem.

Although the management of attention is central, it would be a gross oversimplification not to recognise the plethora of skills necessary for effective teaching. As Brophy and Evertson argue, " Effective teaching is not simply a matter of implenting a small number of basic teaching skills. Instead effective teaching requires the ability to implement a very large number of diagnostic, instructional, managerial and therapeutic skills, tailoring behaviour in specific contexts and situations to the specific needs of the moment." In short, effective teaching involves the orchestration of a large number of factors, continually shifting teaching behaviour to respond to similarly shifting needs. This they argue amounts to a more appropriate conceptualisation of teaching. McNamara and Desforges (1978) argue that teachers and educators must work within a conceptual framework and it is easy to agree with their prescription that the disciplines of education be abandoned in favour of an amalgamation of theory and practice and the development of professional studies as an academically rigorous, practically useful and scientifically productive activity. Dunkin and Biddle's belief might be paraphrased—the study of teaching should be the heartland of teacher preparation.

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SCHOOL ATTENDANCE, ATTAINMENT AND BEHAVIOUR

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SUMMARY. Data from the National Child Development Study are used to examine the relationship between school attendance, at the ages of 7 and 15, and reading and mathematics test scores and school behaviour at the age of 16. A relationship between attendance and attainment is found, which is reduced but remains statistically significant after allowance for related social factors. The relationship between 15-year attendance and attainment is reasonably consistent across categories of the social factors, e.g. for different social classes. The relationship between 7-year attendance and 16-year attainment and behaviour is not significant once allowance for attendance at 15 is made.

INTRODUCTION

IN discussions of school attendance and truancy, it seems rarely to be considered necessary to justify one's concern. There is now a sizeable body of evidence on attendance and truancy levels and their relationship with personal, social and school variables. However, it is usually assumed, understandably perhaps, that the children not attending school do less well scholastically than their peers. Furthermore, when this assumption is made explicit, this can involve somewhat contradictory claims about the direction of causality, as the following quotations exemplify:

> ' His absences caused him to be educationally backward and socially poorly adjusted; on return to school he could hardly fail to notice, and be affected by, his poor attainment and lack of friends; a vicious circle could all too easily be established ' (Galloway, 1976).
>
> ' Fear of being seen as illiterate or semi-literate is a cause of truancy among the older secondary pupil ' (Hopwood, 1975).

Whichever is the primary cause, or whether there is a causal relationship at all, both kinds of argument contain the assumption that children who are frequently absent from school show poor attainment and adjustment to school. In the event, what little evidence there is suggests that this relationship is by no means so straightforward and may not hold for all groups of children.

Douglas and Ross (1965), for example, related composite scores on reading, vocabulary, intelligence and arithmetic tests, taken at the age of 11 by their sample of children born in 1946, to attendance records over the previous four years. Although in general they did find a relationship between average scores and attendance, this did not hold for their ' upper middle class ' group. Among the latter even those who had averaged about eight weeks' absence per year obtained test scores no lower than the best attenders.

A not dissimilar result was reported by Fogelman and Richardson (1974). Again at the age of 11, the reading comprehension, mathematics and general ability tests scores of the National Child Development Study (NCDS) children born in 1958 showed an overall relationship with attendance level in the current year, but when the social class background of the children was taken into account the relationship reached statistical significance only for children whose fathers were in manual occupations.

The purpose of the present paper is to extend this analysis of the NCDS data to the age of 16. Additionally we shall be examining the relationship between attendance and adjustment to school, and attempting to assess the relative importance of poor attendance early and late in the child's school career.

It must be stressed that we shall throughout be looking at actual reported attendance rate. Absences will be due to a variety of reasons and should not be equated with 'truancy'.

The National Child Development Study

This is a long-term study of all children in England, Scotland and Wales born in the week 3rd-9th March, 1958. Originally studied at the time of their birth (Butler and Bonham, 1963), the survivors, and other children born in the same week who came into the country subsequently, have been followed up by the National Children's Bureau at the ages of 7 (e.g. Davie *et al.*, 1972), 11 (e.g. Wedge, 1969) and 16 (e.g. Fogelman, 1976).

The third follow-up took place in the school year 1973-74, that is in the year in which the school leaving age was raised to 16. Thus our sample is part of that year-group which was the first to be required to stay at school for the extra year. Although this is unlikely to have affected the relationships with which we are concerned, it does mean that the overall attendance rate is not directly comparable with other years.

At each follow-up the children's schools completed a questionnaire and administered tests, local authority doctors carried out medical examinations and health visitors interviewed parents. At 11 and 16 only, the young people themselves completed a questionnaire.

The following variables are utilised in the present paper.

School attendance at 7: calculated as a percentage from information provided by the teacher on the number of possible half-day attendances and of actual half-day absences in that school year (that is from September, 1964, to the date of completion of the questionnaire which, for almost all children, fell between March and July, 1965).

School attendance at 15: calculated as above but referring to the autumn term, 1973 (questionnaires were completed in the spring or summer term of the same school year).

Social class: father's occupation as reported in the 16-year parental interview, and classified according to the Registrar-General's (1966) Classification of Occupations. The following categories and abbreviations are used in this paper:

I and II	Professional and managerial
III NM	Other non-manual occupations
III M	Skilled manual
IV	Semi-skilled manual
V	Unskilled manual
NMH	No male head of household

Region: the local authority of the child's home at 16 categorised into the Registrar-General's Standard Regions and for this paper, further combined to give North England, South England, Scotland and Wales.

Overcrowding: calculated from information provided during the parental interview at 16, the classification of 'overcrowded' being ascribed to children living in homes with a ratio greater than 1·5 persons per room.

Reading comprehension test score at 16*:* from a test constructed by the National Foundation for Educational Research for this study and designed to be parallel to the Watts-Vernon reading test. In order to satisfy the assumptions of analysis of variance, scores have been transformed to give a normal distribution with a mean of zero and a standard deviation of one.

Mathematics test score at 16*:* also from a test constructed by the NFER for use with this age group and transformed to the same scale as the reading test. Neither of the above tests has been published, but copies and technical details are available from the author.

School behaviour at 16*:* as assessed by the Rutter school behaviour scale (Rutter, 1967), transformed, to achieve normality, to a scale which has a mean of 1·7 and a standard deviation of 1·4. On this scale, higher scores indicate 'poorer' behaviour.

RESULTS

The simple relationships between attendance at the two ages and scores on the attainment tests and behaviour scales are summarised in Tables 1 and 2, which show the fitted constants from the regression of the scores on grouped attendance rates, without adjustment for any other independent variables. It can be seen that in all cases there is a marked and significant relationship. For all three measures the difference in means between those with 70 per cent or less attendance at 15 and those with better than 95 per cent attendance is roughly one standard deviation of the total sample score.

As might be expected, the relationship between these measures and attendance at 7, is, though still highly significant, less marked—the contrasts being about half as great for reading and maths and even less for school behaviour.

TABLE 1

FITTED CONSTANTS FOR 16-YEAR ATTAINMENT AND BEHAVIOUR IN RELATION TO 15-YEAR SCHOOL ATTENDANCE

15-year Attendance Rates	Reading Score	Maths Score	School Behaviour Score
Up to 70%	−0·49	−0·49	1·01
Up to 85%	−0·19	−0·25	0·24
Up to 95%	0·19	0·17	−0·42
Up to 100%	0·49	0·57	−0·83
N	7670	7634	7962
χ^2 (3 df)	901·0***	1187·6***	1818·3***

In this and all subsequent tables significance levels are indicated: ***P<·001; **P<·01; *P<·05; otherwise P>·05.

TABLE 2

FITTED CONSTANTS FOR 16-YEAR ATTAINMENT AND BEHAVIOUR IN RELATION TO 7-YEAR SCHOOL ATTENDANCE

7-year Attendance Rates	Reading Score	Maths Score	School Behaviour Score
Up to 70%	−0·24	−0·17	0·29
Up to 85%	−0·00	−0·06	0·07
Up to 95%	0·10	0·09	−0·16
Up to 100%	0·14	0·14	−0·20
N	7670	7634	7962
χ^2 (3 df)	39·8***	45·0***	61·0***

The above tables give only the crudest assessment of the relationship with which we are concerned. Previous studies (e.g. Fogelman and Richardson, 1974) have demonstrated the relationship between school attendance and various factors in the child's background. Such relationships continue to be found within our most recent data. For example, Table 3 shows the relationship between social class and school attendance at 15 separately for each sex. Social class differences are in the expected direction, with a clear progression from those in professional families to those with fathers in unskilled manual occupations. The overall slight sex differences are more surprising, and perhaps due to a greater incidence of illness among adolescent girls (further exploration of this question is in progress).

TABLE 3

15-YEAR ATTENDANCE BY SEX AND SOCIAL CLASS (PERCENTAGED)

Social Class	Sex	Attendance Rate				N
		Up to 70%	-85%	-95%	-100%	
I and II	B	3·6	7·2	26·4	62·8	1134
	G	3·9	8·8	31·8	55·5	1145
III NM	B	6·2	9·8	31·3	52·7	533
	G	5·9	13·2	38·1	42·8	470
III M	B	10·7	16·3	32·7	40·3	2021
	G	11·4	18·5	37·3	32·9	1922
IV	B	11·4	17·9	29·5	41·2	614
	G	15·7	19·6	31·4	32·3	592
V	B	23·9	21·0	26·3	28·7	247
	G	22·3	24·3	33·3	20·2	243
NMH	B	14·7	20·1	29·3	35·8	352
	G	18·7	24·9	28·2	28·2	369
TOTAL	B	9·6	14·2	30·1	46·1	4901
	G	10·7	16·6	34·4	38·2	4741

It will be noticed that the total number of children included in Tables 3 and 4 differs from that reported in the analyses of variance (Table 5) and in Tables 1 and 2 which are based on the sample used in the analyses of variance; because the latter incorporate data collected from a number of sources, and in particular at more than one age, there are inevitably children with incomplete information who cannot be included. Dependent variable means for the reduced sample do not differ greatly from those for the total sample, so it seems reasonable to conclude that the former is still a representative sample (for a detailed analysis of response patterns in this sample see Goldstein, 1976).

Table 4 presents the distribution of attendance rates for the three home countries, with England divided into North and South.

The contrasts in this table are marked. About one in 12 of 16-year-olds in the South of England were absent for 30 per cent or more of the time in the autumn term of 1973, whereas the figure for Wales is just over one in five.

A further factor which has been demonstrated to be related to attendance rate is the child's housing circumstances, and a discussion of the NCDS findings on this topic (Tibbenham, 1977) has demonstrated, in particular, the relevance of whether or not the child lives in an overcrowded home.

Thus an adequate account of the relationship between attendance and attainment must take account of such background variables as the above, by means of a multivariate analysis. Additionally, it is informative to include both 7-year and

TABLE 4

15-YEAR ATTENDANCE BY REGION

Region	Attendance Rate Up to 70%	-85%	-95%	-100%	N
North England	11·0	15·8	31·3	41·8	5305
South England	8·4	14·2	32·2	45·3	4391
Scotland	13·0	17·2	32·6	37·2	1375
Wales	20·2	19·6	28·9	31·2	663

15-year attendance in these analyses as independent variables, as it is then possible to compare the relative strength of their relationship with attainment and, by inspection of the interactions, assess the remediability of any effects of early absence.

Before turning to the results, it may be helpful to provide a brief explanatory note on their presentation, some aspects of which may not be familiar to all readers.

(i) The fitted constants are calculated from unstandardised regression coefficients. Thus their absolute values cannot be equated with the adjusted mean scores of the groups concerned, but the *differences* among them can be considered as equivalent to the differences among mean scores. For a fuller account of this method of analysis, see the statistical appendix to Davie *et al.* (1972).

(ii) In Table 5, in order to save space, for variables which have two values only (e.g. sex), the difference between the two fitted constants is presented.

(iii) As has been mentioned the fitted constants are from scales which have standard deviations of 1.0, in the case of the reading and mathematics tests, and 1.4, for the behaviour scale.

(iv) In samples of this size the χ^2 test is equivalent to an F-test, and is preferred because of its simplicity.

Analysis of Variance Results: Main Effects

The results of the three analyses, that is with reading, mathematics and behaviour scores as dependent variables, are summarised in Table 5.

The analyses reported in Table 5 enable us to estimate the mean differences associated with the various levels of attendance, once allowance has been made for the other independent variables included in the analysis. For example, in reading test scores there is a mean difference of 0·72 (of a standard deviation) between those with 70 per cent or less attendance at 15 and those with between 95 and 100 per cent, and this figure is adjusted to take into account any differences between these two groups in their attendance at 7, their sex, social class and regional distribution and whether or not they lived in an overcrowded home.

It will be noted that ‘ region ’ has not been included as an independent variable in the analysis of school behaviour scores. This is because no initial relationship was found between those two variables, even before allowance for other factors.

The effect of the analyses of variance is to reduce the contrasts associated with different attendance levels, but not very markedly in the case of 15-year attendance. In comparison with Table 1, the contrasts between children at the two extremes of attendance are reduced by about 25 per cent in the case of reading and mathematics, but only by about 6 per cent for the school behaviour scale. In this last case then the difference between the best and poorest attenders, as categorised, still amounts to nearly one standard deviation.

TABLE 5

ANALYSES OF VARIANCE SUMMARY

		Dependent Variables					
		16-year Reading Score		16-year Mathematics Score		16-year School Behaviour Scale	
Independent Variables		Fitted Constants	χ^2 (df)	Fitted Constants	χ^2 (df)	Fitted Constants	χ^2 (df)
Attendance at 7:	<70%	−0·13	7·6 (3)	−0·05	2·4 (3)	0·11	4·8 (3)
	Up to 85%	0·04		−0·01		0·01	
	Up to 95%	0·04		0·02		−0·05	
	Up to 100%	0·05		0·03		−0·05	
Attendance at 15:	<70%	−0·36	477·0 (3)***	−0·38	711·9 (3)***	0·94	1424·1 (3)***
	Up to 85%	−0·14		−0·20		0·22	
	Up to 95%	0·14		0·13		−0·38	
	Up to 100%	0·36		0·45		−0·78	
Sex:	(Boys—Girls)	0·02	1·1 (1)	0·14	51·2 (1)***	0·29	112·3 (1)***
Social Class:	I & II	0·46	621·0 (5)***	0·48	598·0 (5)***	−0·27	112·7 (5)***
	III NM	0·27		0·20		−0·18	
	III M	−0·06		−0·05		0·00	
	IV	−0·19		−0·14		−0·02	
	V	−0·42		0·33		0·22	
	NMH	−0·06		−0·16		0·21	
Region:	North	−0·02	14·7 (3)***	−0·06	31·1 (3)***		
	South	0·06		0·01			
	Wales	−0·04		−0·05			
	Scotland	0·00		0·11			
Overcrowding:	(No—Yes)	0·39	98·0 (1)***	0·23	33·3 (1)***	−0·26	26·3 (1)***
	Residual Mean Square		0·777		0·766		1·42
	Significant Interactions	Attendance at 15 × Sex $\chi^2=8{\cdot}09$ (3)*		Attendance at 15 × Social Class $\chi^2=31{\cdot}7$ (15)***		Attendance at 15 × Sex $\chi^2=19{\cdot}1$ (3)*** Attendance at 15 × Social Class $\chi^2=28{\cdot}0$ (15)***	
	Total Variance	0·966		0·972		1·80	
	Sample Size	7670		7634		7962	

A further estimate of the importance of these differences associated with attendance can be gained by comparing them with the differences in the analyses associated with social class. In each case the extreme social class comparison is between children of fathers in professional or managerial jobs and those in unskilled manual jobs. On the reading test the adjusted mean difference between these two groups is only very slightly larger than that between the two extreme 15-year attendance groups. On the mathematics test it is slightly smaller, and on the behaviour scale it is less than one-third the size. In general, scores on the behaviour scale appear to be less closely related to social factors than do the attainment test scores, which suggests that an even greater importance could be attached to the strong relationship between attendance and school behaviour, although it should be noted that the behaviour scale does contain two items—' truants ' and ' absent for trivial reasons '—which will apply, by definition to some of the absentees. Furthermore, there may be a ' halo ' effect with teachers more likely to give adverse ratings to frequent absentees.

A further point worthy of note is that the relationship between 15-year attendance and each of the dependent variables is reasonably linear. To some extent this must be due to the way we have categorised attendance levels, but it may also suggest that there is not a threshold relationship between the two—i.e. that decreases in school attendance are associated with reasonably regular decrements in attainment.

The differences associated with 7-year attendance which, as we saw in Table 1, were already considerably smaller when unadjusted for other factors, have now decreased to the extent that they do not reach statistical significance at the 5 per cent level. This finding is discussed further below in the section specifically concerned with the relationship between attendance at 7 and at 15.

Interactions

The preceding paragraphs summarised the overall differences associated with different attendance rates. However, it is important to know whether such differences are similar among, for example, boys and girls or children from different social class backgrounds. In particular, as already mentioned, previous work has suggested a different relationship for working class and middle class children at the age of 11.

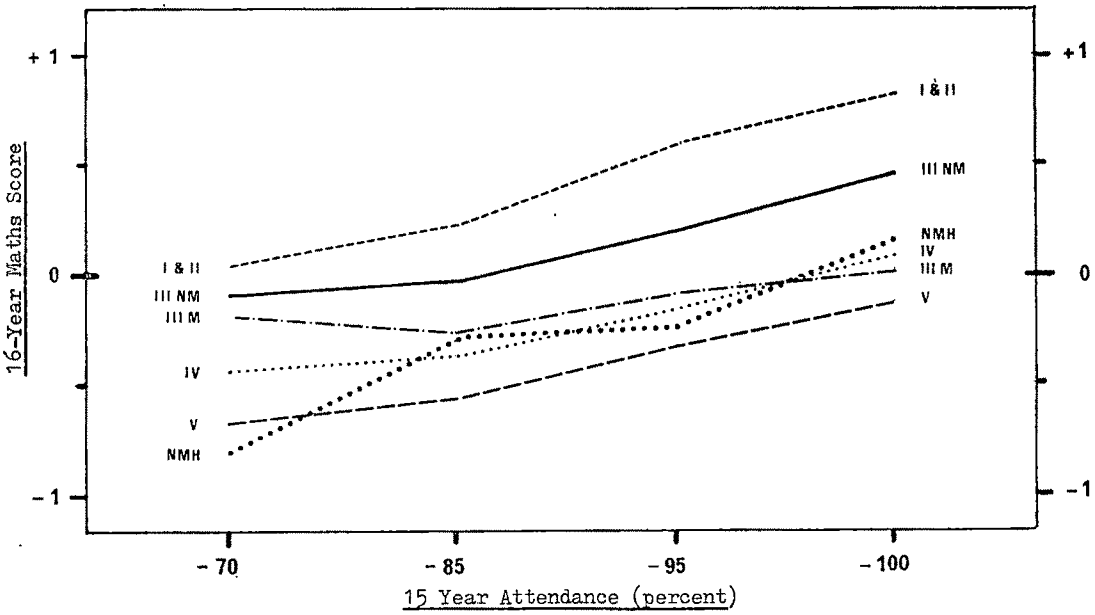
Such relationships have been examined by testing for the presence of significant interactions, in each of the analyses summarised in Table 5, between attendance at 15 and each of the other independent variables in the analyses. Those reaching significance are indicated in the table. It will be seen that in no case is there a significant interaction between attendance at 15 and attendance at 7, region or overcrowding. Thus the overall differences reported above can be taken as being reasonably constant for different parts of the country and for children in different housing circumstances (at least as measured by overcrowding), and neither do they seem to be related to the child's earlier attendance level at the age of 7.

For reading test scores there is no evidence of an interaction between attendance and social class, and the only significant interaction which does appear is with sex. However, inspection of the fitted constants obtained when this interaction is fitted (available from the authors), shows this finding to be relatively trivial. It arises from the fact that within the poorest and the best attendance group, the girls obtain slightly higher reading scores whereas in the intermediate groups the reverse is true. However, in each case the difference is extremely small, and this interaction is probably best ignored.

On the mathematics test, no interaction was found between attendance and sex, but one does appear between attendance and social class. However, it can be seen from Figure 1 that this does not offer support for any real differentiation between the social classes. The relationship between attendance and mathematic attainment is slightly less marked for the skilled manual (IIIM) group than for the other social class

FIGURE 1

16-YEAR MATHEMATICS SCORE: ATTENDANCE AT 15 × SOCIAL CLASS INTERACTION



groups, but clearly the main contribution to the interaction arises from the pattern of those children in families with no male head. Among these children the poorest attenders obtain the lowest mathematics scores of all the groups, but instead of the reasonably steady improvement with increased attendance shown by other groups, there is a much more marked increase in scores to the point where the mean score of the best attenders is higher than those of any of the working class groups. This may suggest a strong dichotomy between those fatherless families experiencing severe problems, failing to get the child into school and the child doing extremely poorly at mathematics, and those who are able to cope well.

For the school behaviour scale, significant interactions appear between attendance and both sex and social class. Again they are not such as to have any major effect on our interpretations. Boys obtain constantly higher scores (i.e. exhibit more deviant behaviour) for all attendance groups but one, the group having between 70 and 85 per cent attendance, where the mean scores of the two sexes are virtually identical. It is difficult to offer even a most speculative explanation for this.

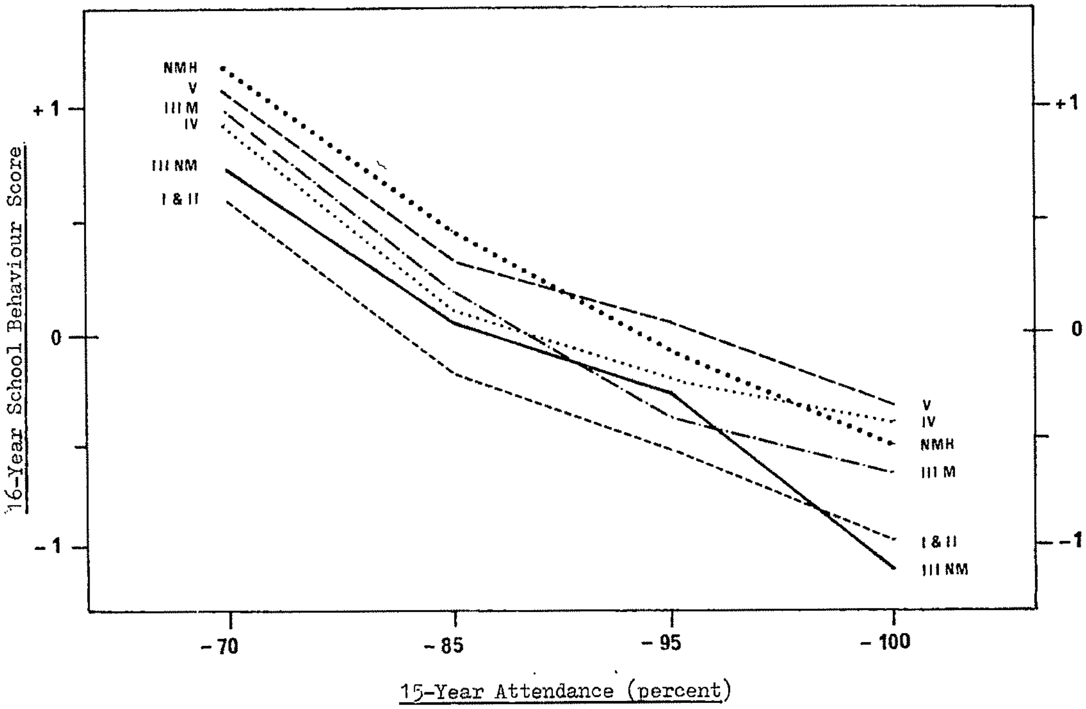
The social class patterns are shown in Figure 2. The behaviour score differences between the best and poorest attenders are really very similar and no clearly consistent patterns appear in this figure, except that there is once again an indication of the children with no male head of household improving their relative position as their attendance increases. Also the relatively good behaviour ratings of the best attenders among the skilled non-manual group is worthy of note.

Attendance at 7 and at 15

As Table 6 shows, although there is an obvious association between attendance at the two ages, there are a substantial number of children who were poor attenders at 7, but whose attendance is at acceptable levels at 15.

FIGURE 2

16-YEAR SCHOOL BEHAVIOUR SCORE: ATTENDANCE AT 15 × SOCIAL CLASS INTERACTION



Conversely, and in absolute terms the number of children concerned is far larger, there are many whose attendance was good at 7 but who were frequently absent when they were 15.

Given then that there are considerable changes in many pupils' attendance record in the course of their school career, the question which arises naturally is whether those children whose attendance is poor at the age of seven show a lasting deterioration in attainment and behaviour, or whether this is offset by good attendance later on. To a certain extent this can be answered on the basis of data already presented in Tables 2 and 5. From Table 2 we see that there certainly is a significant simple relationship between 7-year attendance and the 16-year outcomes with which we are concerned, in each case the poorest attenders' scores being on average approximately one-third of a standard deviation worse than those of the best attenders.

TABLE 6

A COMPARISON OF ATTENDANCE AT AGES 7 AND 15

Attendance at seven	Attendance at fifteen Up to 70%	Up to 85%	Up to 95%	Up to 100%	N
Up to 70%	25·8	20·6	25·8	27·9	330
Up to 85%	17·9	20·8	32·9	28·4	1600
Up to 95%	9·8	16·0	33·3	40·9	4430
Up to 100%	8·7	11·5	31·4	48·3	4523

To take the answer a stage further we need to know to what extent these would be reduced if the relevant background variables, but *not* 15-year attendance, were taken into account. This can be established by repeating the analysis reported in Table 5, omitting 15-year attendance from the independent variables. Table 7 presents the fitted constants associated with 7-year attendance from such an analysis. (Note that of course the fitted constants associated with the other independent variables will also differ from those in Table 5, although in the event not markedly. The full results of this analysis are available from the author.)

TABLE 7

COMPARISON BETWEEN ATTENDANCE AT AGE 7 AND 16-YEAR ATTAINMENT AND BEHAVIOUR: FITTED CONSTANTS FROM ANALYSIS OF VARIANCE

Attendance at seven	Reading	Mathematics	Behaviour Score
Up to 70%	-0·17	-0·10	0·23
Up to 85%	0·00	-0·05	0·08
Up to 95%	0·07	0·06	-0·13
Up to 100%	0·10	0·09	-0·18
χ^2 (3 df)	24·8***	24·9***	47·8***

As would be expected, the contrasts in this table are greater than those in Table 5, but they are still not very large. The first answer to our question then is that the level of attendance of a child at the age of 7 does continue to have a slight relationship with attainment and behaviour at 16, even when associated background variables have been allowed for.

However, as the earlier analysis showed, when the relationship between attendance rates at 7 and at 15 is also taken into account any effects of 7-year attendance are reduced to the point where they do not reach statistical significance.

Furthermore, as already stated, there were in these analyses no significant interactions between attendance levels at the two ages. Thus the relatively high attainment of the good attenders and the low attainment of the poor attenders, and the size of the contrast between the two groups of children, at 16, would appear to hold irrespective of their earlier attendance rate.

CONCLUSIONS

From these findings a fairly clear, straightforward relationship between school attendance and attainment and behaviour appears in that children with high attendance levels obtain on average higher scores on tests of reading comprehension and mathematics and are less often indicated by their teachers as showing deviant behaviour. Although we have been concerned with actual attendance rates irrespective of causes of absence, rather than truancy, this last result is consistent with Tyerman's (1968) suggestion that truancy should be taken as a warning of possible emotional problems.

Contrary to what has been found at the age of 11 for both the cohort of children born in 1946 and the children born in 1958 on whom the present paper is based, at 16 there is no evidence that this relationship differs according to social class. Apart from the mathematics scores of children with no male head of household, the differences in attainment and behaviour of children with varying levels of attendance are more or less constant for each social class.

By the time these children were in their final year of compulsory schooling, there was little relationship between their attainment and their attendance rate early in the primary school. This is not to suggest that early non-attendance can be ignored (since it does predict later poor attendance, and such continued absence is related to low attainment). It is in fact a rather optimistic finding, suggesting as it does that a child who misses even a considerable amount of school at an early age will be able to overcome any resulting disadvantage through subsequent regular attendance.

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TEACHER STRESS: PREVALENCE, SOURCES, AND SYMPTOMS

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SUMMARY. A questionnaire survey was used to investigate the prevalence, sources, and symptoms of stress among 257 schoolteachers in 16 medium-sized, mixed comprehensive schools in England. About one-fifth of the teachers rated being a teacher as either very stressful or extremely stressful. There appeared to be little association between self-reported teacher stress and the biographical characteristics of the teachers. Sources of stress with relatively high mean stress ratings included ' pupils' poor attitudes to work ', ' trying to uphold/maintain values and standards ', and ' covering lessons for absent teachers '. A principal components analysis of the sources of stress revealed four factors labelled ' pupil misbehaviour ', ' poor working conditions ', ' time pressures ', and ' poor school ethos '. The most frequent symptoms of stress reported were ' exhaustion ' and feeling ' frustrated '. A principal components analysis of the symptoms of stress revealed one factor labelled ' awareness of stress symptoms ' which appeared to be largely defined by reported frequency of feeling ' very tense '.

INTRODUCTION

DUNHAM (1976) has drawn attention to the prevalence of stress among schoolteachers. In a survey that included reports from 658 infant, junior, and secondary schoolteachers, he concluded that more teachers are experiencing stress, and that severe stress is being experienced by more teachers.

Kyriacou and Sutcliffe (1978) have defined ' teacher stress ' as a response syndrome of negative affects (such as anger or depression) resulting from the teacher's job. In a review of teacher stress, Kyriacou and Sutcliffe (1977) found that little research conducted in the United Kingdom has been reported that attempted to measure the extent to which teachers feel they are experiencing stress or to identify the aspects of the teacher's job which teachers regard as the major sources of stress.

The present study was designed to answer four questions concerning teacher stress:

(i) to what extent do teachers feel they are experiencing stress?
(ii) what do teachers feel are the main sources of stress?
(iii) what are the most frequent symptoms experienced?
(iv) are there differences in the answers to questions (i) to (iii) for different biographical subgroups?

The present study took the form of a questionnaire survey and was confined to a sample of teachers in medium-sized, mixed comprehensive schools in England.

Implicit in the design of this study was the assumption that teachers are able to provide valid reports of the sources of experienced stress. This approach places emphasis on the teacher's report of his subjective appraisal of his circumstances and has been discussed fully elsewhere (Kyriacou and Sutcliffe, 1978).

METHOD

Questionnaire

The questionnaire consisted of four sections. The first section requested biographical information regarding sex, qualification, age, length of teaching experience, and position held in the school. The format of this section consisted of multiple-choice class divisions. The second section consisted of 51 items regarding sources of stress (see Table 2) which the teacher was asked to rate in response to the question " As a teacher, how great a source of stress are these factors to you? " on a five-point scale labelled ' no stress ', ' mild stress ', ' moderate stress ', ' much stress ', and ' extreme stress '. The third section asked teachers to rate their response to the question " In general, how stressful do you find being a teacher? " on a five-point scale labelled ' not at all stressful ', ' mildly stressful ', ' moderately stressful ', ' very stressful ', and ' extremely stressful '. The response to this question was used as a measure of self-reported teacher stress. Finally, the fourth section consisted of 17 items regarding symptoms of stress (see Table 5) which teachers were asked to rate in response to the question " Please estimate how frequently during the school term you feel in these ways " on a five-point scale labelled ' never ', ' rarely ', ' about once a week ', ' about once a day ', and ' many times a day '.

The items used and the format of the questionnaire were developed following a review of the research literature, interviews with teachers, and two pilot studies. In particular, it should be noted that the sources and symptoms of stress employed as items in the questionnaire were largely those that have been spontaneously reported by teachers themselves. All three five-point response scales were scored 0 to 4.

Sample and procedure

16 schools in England were randomly selected from the *Education Authorities Directory*, 1977, with the constraints that they should be mixed comprehensive schools with between 900 and 1,100 pupils (as indicated by the directory), and that the proportion of the schools situated in a city, in each of three geographical subdivisions of England, and whose pupils normally ranged up to 16 or 18 years of age, should conform to the national pattern (DES, 1976, 1977). Information from the schools revealed that the size of the schools in the sample in fact ranged from 900 to 1,205 pupils with a mean of 1,002.

With the co-operation of the head teachers 20 envelopes, each containing a questionnaire, a covering letter, and a stamped addressed envelope, were sent to each school with instructions to enable these to be distributed randomly to the teachers via their pigeon holes. All questionnaires were to be filled in anonymously. 259 questionnaires were returned. Two of these were excluded from the analyses, one being filled in by a part-time teacher, the other being returned incomplete. The remaining 257 questionnaires accounted for 80·3 per cent of those distributed. These respondents were all full-time teachers and did not include heads of schools or deputy heads. The biographical characteristics of the respondents are shown in Table 1.

RESULTS

Prevalence

The responses of the 257 teachers to the question " In general, how stressful do you find being a teacher? " are shown in Table 1 for the total sample and for each of the biographical subgroups. Approximately 20 per cent of the respondents rated being a teacher as either very stressful or extremely stressful.

To investigate whether self-reported teacher stress was associated with the biographical characteristics of the teachers, four separate two-way factorial analyses of variance were performed with self-reported teacher stress as the dependent variable, sex as the first independent variable, and each of the remaining four biographical characteristics (qualification, age, length of teaching experience, and position held in the school) as the second independent variable in turn. The categories employed are shown in Table 1. For the variable ' position held in the school ' only the categories ' teacher ' and ' head of department ' were compared; the third category, ' others ', consisted of heads of houses and heads of years who were not also heads of departments and contained too few teachers ($N = 17$) for adequate comparison. All four analyses revealed no significant differences (for $P < \cdot 05$) for all the main effects and interaction terms.

TABLE 1

SELF-REPORTED TEACHER STRESS: DISTRIBUTION OF RESPONSES AND MEANS FOR THE TOTAL SAMPLE AND FOR BIOGRAPHICAL SUBGROUPS

		Percentage distribution					
	N	not at all stressful	mildly stressful	moderately stressful	very stressful	extremely stressful	Mean
Total	257	4·7	37·7	37·7	15·6	4·3	1·77
*Sex**							
Male	143	3·5	40·6	37·1	15·4	3·5	1·75
Female	113	6·2	34·5	38·1	15·9	5·3	1·80
Qualification							
University Graduate	107	0·9	39·3	39·3	15·9	4·7	1·84
Others	150	7·4	36·9	36·9	15·4	4·0	1·72
*Age**							
Under 30 years	98	3·1	32·7	39·8	19·4	5·1	1·91
30 to 44 years	106	4·7	39·6	35·8	15·1	4·7	1·75
45 years and over	52	7·7	42·3	38·5	9·6	1·9	1·56
Length of teaching experience							
0 to 4 years	73	5·5	32·9	38·4	19·2	4·1	1·84
5 to 10 years	89	3·4	37·1	37·1	19·1	3·4	1·82
Over 10 years	95	5·3	42·1	37·9	9·5	5·3	1·67
Position held in the school							
Teacher	159	4·4	34·6	38·4	17·6	5·0	1·84
Head of Department	81	3·7	44·4	34·6	13·6	3·7	1·69
Others	17	11·8	35·3	47·1	5·9	0	1·47

* One subject failed to give information regarding sex, another regarding age.

Sources of stress

The mean ratings of the responses to the 51 sources of stress are shown in Table 2.

The responses for each item ranged from ' no stress ' to ' extreme stress '. For all but one item the distribution of the responses was approximately normal or positively skewed. This skewness ranged from −·004 to 1·235; the standard deviations from 0·924 to 1·385. The exception was item 32, ' inadequate salary ', which a disproportionate number of teachers (12·8 per cent) rated a source of extreme stress, resulting in the underlying distribution appearing to be bimodal.

A correlation matrix of the 51 sources of stress consisted almost entirely of positive correlations (1265 out of 1275). Furthermore, all 51 sources of stress were positively correlated with self-reported teacher stress (r ranging from ·120 to ·550; all $P < \cdot 05$) (see Table 2).

The 51 sources of stress were subjected to a principal components analysis. The first extracted factor accounted for 32·7 per cent of the total variance, with all 51 items loading positively on this factor. These loadings ranged from ·262 to ·741, and are shown in Table 2. Varimax rotation of the first four extracted factors (eigen values 16·7, 4·95, 3·04, and 2·07 respectively) yielded the best rotated factor matrix with an orthogonal solution (i.e. as many items as possible loading highly on only one factor). These four rotated factors accounted for 18·6 per cent, 12·2 per cent, 11·9 per cent, and 9·3 per cent of the total variance respectively. The items with loadings greater than ·40 are shown in Table 3.

Factor I was labelled ' pupil misbehaviour ', factor II ' poor working conditions ', factor III ' time pressures ', and factor IV ' poor school ethos '.

To investigate whether there were any differences in responses to the sources of stress for the different biographical subgroups, the means of the responses were

TABLE 2

SOURCES OF STRESS: MEANS, CORRELATIONS WITH SELF-REPORTED TEACHER STRESS AND LOADINGS ON THE FIRST (UNROTATED) FACTOR

Item no.	Source of stress	Mean	Correlation with self-reported stress	Loading on first (unrotated) factor
16	pupils' poor attitudes to work	1·965	·436	·708
12	trying to uphold/maintain values and standards	1·930	·471	·694
10	poorly motivated pupils	1·910	·365	·619
38	covering lessons for absent teachers	1·868	·296	·551
5	too much work to do	1·820	·550	·523
37	lack of time to spend with individual pupils	1·777	·291	·563
35	individual pupils who continually misbehave	1·738	·463	·676
39	pupils who show a lack of interest	1·691	·369	·685
7	not enough time to do the work	1·664	·456	·491
8	lack of time for marking	1·609	·392	·441
19	attitudes and behaviour of some other teachers	1·600	·211	·385
15	inadequate disciplinary policy of school	1·587	·385	·626
11	difficult classes	1·572	·361	·563
20	pupils' non-acceptance of teacher's authority	1·565	·517	·681
4	constant monitoring of pupils' behaviour	1·547	·510	·614
45	generally high noise level	1·539	·454	·632
29	noisy pupils	1·532	·426	·627
44	large classes	1·514	·372	·559
42	pupils' impolite behaviour or cheek	1·490	·423	·652
23	inadequate disciplinary sanctions available	1·486	·408	·718
41	difficult behaviour problems	1·467	·472	·669
26	pupils' general misbehaviour	1·438	·500	·741
28	groups of too wide an ability	1·410	·240	·551
36	too much paperwork	1·382	·289	·429
2	lack of time to prepare lessons	1·370	·433	·521
34	poor promotion opportunities	1·344	·243	·600
32	inadequate salary	1·331	·120	·434
9	lack of recognition for extra work	1·327	·293	·546
48	attitudes and behaviour of the headmaster	1·310	·341	·513
25	non-exam final year pupils	1·302	·303	·560
18	lack of consensus on minimum standards	1·300	·295	·595
13	school too large	1·282	·373	·502
40	demands on after school time	1·246	·346	·376
14	responsibility for pupils (e.g. exam success)	1·241	·398	·478
33	no time to relax between lessons	1·238	·411	·521
49	too many periods actually teaching	1·230	·450	·618
21	lack of time for further study	1·230	·357	·570
3	punishing pupils	1·226	·366	·444
50	poor career structure	1·205	·206	·624
47	mixed ability groups	1·203	·208	·523
24	lack of effective consultation	1·198	·320	·642
1	administrative work	1·197	·308	·262
46	supervisory duties (e.g. playground, school meals)	1·195	·427	·585
17	low status of the teaching profession	1·156	·210	·541
43	lack of participation in decision-making	1·098	·318	·612
6	pace of school day is too fast	1·093	·451	·417
51	pupils' general low ability	1·082	·284	·662
30	maintaining class discipline	1·063	·514	·531
27	lack of recognition for good teaching	1·043	·279	·618
22	shortage of equipment	1·043	·237	·543
31	poor facilities	0·953	·250	·489

TABLE 3

SOURCES OF STRESS: LOADINGS GREATER THAN ·40 ON VARIMAX ROTATED FACTORS

Factor I ' Pupil misbehaviour '

Loading	Item no.	Source of stress
·819	29	noisy pupils
·810	11	difficult classes
·789	41	difficult behaviour problems
·775	42	pupils' impolite behaviour or cheek
·759	35	individual pupils who continually misbehave
·750	26	pupils' general misbehaviour
·750	20	pupils' non-acceptance of teacher's authority
·746	30	maintaining class discipline
·724	45	generally high noise level
·616	16	pupils' poor attitudes to work
·590	39	pupils who show a lack of interest
·574	10	poorly motivated pupils
·562	4	constant monitoring of pupils' behaviour
·536	3	punishing pupils
·528	12	trying to uphold/maintain values and standards
·523	51	pupils' general low ability
·513	23	inadequate disciplinary sanctions available
·500	28	groups of too wide an ability
·450	47	mixed ability groups
·423	25	non-exam final year pupils

Factor II ' Poor working conditions '

Loading	Item no.	Source of stress
·737	50	poor career structure
·707	34	poor promotion opportunities
·679	32	inadequate salary
·644	22	shortage of equipment
·615	27	lack of recognition for good teaching
·584	43	lack of participation in decision-making
·579	44	large classes
·542	9	lack of recognition for extra work
·530	31	poor facilities
·511	49	too many periods actually teaching
·508	17	low status of the teaching profession
·444	38	covering lessons for absent teachers
·436	46	supervisory duties (e.g. playground, school meals)
·423	40	demands on after school time
·409	24	lack of effective consultation
·404	47	mixed ability groups

Factor III ' Time pressures '

Loading	Item no.	Source of stress
·793	7	not enough time to do the work
·777	5	too much work to do
·728	1	administrative work
·684	36	too much paperwork
·660	2	lack of time to prepare lessons
·603	6	pace of school day is too fast
·592	8	lack of time for marking
·511	14	responsibility for pupils (e.g. exam success)
·511	40	demands on after school time
·491	37	lack of time to spend with individual pupils
·456	49	too many periods actually teaching
·455	33	no time to relax between lessons
·434	21	lack of time for further study

TABLE 3 (*cont.*)

Factor IV ' Poor school ethos '

Loading	Item no.	Source of stress
·675	15	inadequate disciplinary policy of school
·614	18	lack of consensus on minimum standards
·572	48	attitudes and behaviour of the headmaster
·558	23	inadequate disciplinary sanctions available
·543	24	lack of effective consultation
·534	19	attitudes and behaviour of some other teachers
·486	16	pupils' poor attitudes to work
·452	10	poorly motivated pupils
·448	9	lack of recognition for extra work
·418	12	trying to uphold/maintain values and standards

compared for each biographical subgroup in turn. T-tests were employed to compare differences for sex, qualification, and position held in the school (again only the categories ' teacher ' and ' head of department ' were compared for this variable); one-way analyses of variance followed by a Student-Newman-Keuls test were employed for age and length of teaching experience. The items for which significant differences were obtained are shown in Table 4.

Female teachers appeared to find several items regarding pupil misbehaviour greater sources of stress than their male colleagues, whereas the latter reported greater stress for administrative and paperwork. University graduates reported less stress than their colleagues on a mixture of items in the main to do with poor working conditions and poor school ethos. Younger and less experienced teachers differed from their colleagues on a range of items which included reporting greater stress on ' punishing pupils ', ' difficult classes ', ' maintaining class discipline ', ' poor promotion opportunities ', ' lack of participation in decision-making ', and ' attitudes and behaviour of the headmaster '. Well over half the items were rated greater sources of stress by ' teachers ' as compared with ' heads of departments ', the only reversals being for administrative and paperwork.

To examine whether any interactions between sex and each of the other four biographical characteristics may have occurred, the means of the biographical subgroups were inspected. Where inspection of the tables indicated the possibility of such an interaction, a two-way factorial analysis of variance was performed. These analyses revealed seven significant two-way interactions. These are also shown in Table 4. A sex by qualification interaction for item 40 indicated that male non-university graduates found demands on after school time more stressful than their colleagues; sex by age for item 17 indicated that female teachers aged 45 or more found low status of the teaching profession less stressful than their colleagues; sex by length of teaching experience for items 9, 20 and 37 indicated that less experienced male teachers and more experienced female teachers found lack of recognition for extra work, pupils' non-acceptance of teacher's authority, and lack of time to spend with individual pupils a greater source of stress than their colleagues; finally, sex by position held in the school for items 9 and 43, indicated that male heads of departments found lack of recognition for extra work and lack of participation in decision-making less a source of stress than their colleagues.

Symptoms of stress

The mean ratings of the responses to the 17 symptoms of stress are shown in Table 5.

For each item the distribution of the responses was positively skewed. This skewness ranged from ·300 to 2·882; the standard deviations from 0·464 to 1·122.

TABLE 4

SOURCES OF STRESS: BIOGRAPHICAL DIFFERENCES IN MEANS

Item no.	Source of stress	Biographical characteristics				
		Sex	Qualification	Age	Experience	Position
1	administrative work	M>F**			L2,L3>L1*	HD>T*
3	punishing pupils	F>M**		A1>A2,A3*	L1,L2>L3*	
4	constant monitoring of pupils' behaviour					T>HD*
9	lack of recognition for extra work		Q2>Q1**		Int*	Int*
10	poorly motivated pupils					T>HD*
11	difficult classes			A1>A2,A3*	L1>L2,L3*	T>HD**
13	school too large				L3>L1*	
15	inadequate disciplinary policy of school		Q2>Q1**			T>HD**
16	pupils' poor attitudes to work					T>HD**
17	low status of the teaching profession		Q2>Q1**	Int*		
18	lack of consensus on minimum standards		Q2>Q1**			
20	pupils' non-acceptance of teacher's authority	F>M*		A1>A2,A3*	Int*	T>HD**
22	shortage of equipment		Q2>Q1*		L1,L2>L3*	T>HD**
23	inadequate disciplinary sanctions available		Q2>Q1*	A1>A2*		T>HD**
24	lack of effective consultation					T>HD*
26	pupils' general misbehaviour	F>M*			L1>L2,L3*	T>HD**
27	lack of recognition for good teaching		Q2>Q1**			T>HD**
28	groups of too wide an ability		Q2>Q1*			T>HD**
29	noisy pupils	F>M**				T>HD**
30	maintaining class discipline			A1>A2*	L1>L3*	T>HD*
31	poor facilities				L1,L2>L3*	T>HD**
32	inadequate salary		Q2>Q1**		L1,L2>L3*	T>HD**
34	poor promotion opportunities		Q2>Q1*	A1>A2,A3*	L1,L2>L3*	T>HD**
35	individual pupils who continually misbehave	F>M*				T>HD**
36	too much paperwork	M>F*			L2,L3>L1*	HD>T*
37	lack of time to spend with individual pupils				Int**	
39	pupils who show a lack of interest					T>HD**
40	demands on after school time		Int*			
41	difficult behaviour problems	F>M*			L1>L2,L3*	T>HD*
42	pupils' impolite behaviour or cheek	F>M*				T>HD**
43	lack of participation in decision-making			A1>A2,A3*	L1,L2>L3*	Int*
44	large classes	F>M*				T>HD**
45	generally high noise level	F>M**				T>HD*
46	supervisory duties (playground, meals)				L2>L3*	
47	mixed ability groups					T>HD*
48	attitudes and behaviour of headmaster			A1>A2,A3*	L1,L2>L3*	T>HD**
50	poor career structure				L1,L2>L3*	T>HD**
51	pupils' general low ability	F>M*			L1,L2>L3	T>HD**

Key: Sex: M=Male, F=Female
Qualification: Q1=University Graduates, Q2=Others
Age: A1=Under 30 years, A2=30 to 44, A3=45 or more
Length of teaching experience: L1=0 to 4 years, L2=5 to 10, L3=over 10
Position held in the school: T=Teacher, HD=Head of Department
Int=Interaction with Sex
* P<·05, ** P<·01

A correlation matrix of the 17 symptoms of stress consisted entirely of positive correlations. Furthermore all 17 symptoms of stress correlated positively with self-reported teacher stress (*r* ranging from ·109 to ·610; all P<·05) (see Table 5).

The 17 symptoms of stress were subjected to a principal components analysis. The first extracted factor accounted for 34·8 per cent of the total variance, with all 17 items loading positively on this factor. These loadings ranged from ·205 to ·810 and are shown in Table 5. A varimax rotated factor matrix with an orthogonal solution for two or more extracted factors did not indicate the presence of more than one common factor. It appears that the variance not accounted for by the first extracted

TABLE 5

SYMPTOMS OF STRESS: MEANS, CORRELATIONS WITH SELF-REPORTED TEACHER STRESS AND LOADINGS ON THE FIRST (UNROTATED) FACTOR

Item no.	Symptom of stress	Mean	Correlation with self-reported stress	Loading on first (unrotated) factor
15	exhausted	2·047	·525	·650
5	frustrated	1·841	·610	·661
12	under stress	1·559	·589	·810
17	very angry	1·441	·214	·414
8	very tense	1·244	·600	·807
6	anxious	1·242	·433	·706
13	depressed	1·191	·462	·680
1	nervous	0·969	·339	·603
2	headaches	0·918	·288	·446
9	heart beating fast	0·782	·362	·634
14	unable to cope	0·512	·399	·664
3	loss of voice	0·502	·109	·205
16	increased blood pressure	0·460	·208	·428
7	panicky	0·448	·334	·634
10	acid in stomach	0·425	·208	·478
4	tearful	0·241	·204	·474
11	cold sweat	0·199	·190	·371

factor is largely made up of the unique variance contained in each item, although there did appear to be some common variance between the items ' increased blood pressure ', ' heart beating fast ', and ' cold sweat ' not accounted for by the first extracted factor. Factor I was labelled ' awareness of stress symptoms '.

Sex differences were investigated for the symptoms of stress. A t-test was performed for each of the items to compare the mean responses for males and females. These analyses revealed that females reported significantly more frequent symptoms for three items, ' headaches ' ($P < \cdot 001$), ' tearful ' ($P < \cdot 001$), and ' exhausted ' ($P < \cdot 05$).

DISCUSSION

The results of the present study are that about 20 per cent of the 257 teachers in the sample of 16 medium-sized, mixed comprehensive schools in England reported that being a teacher is either very stressful or extremely stressful. To the extent that self-reported teacher stress can be considered an accurate measure of teacher stress these results indicate that about one-fifth of the teachers in this study are experiencing a large amount of stress.

The results also indicate that there is very little association between self-reported teacher stress and the biographical characteristics of sex, qualification, age, length of teaching experience, and position held in the school. As such, it may well be the case that in investigating the relationship between stressors and stress (Warr and Wall, 1975) the personality characteristics rather than the biographical characteristics of the individual may be the more important determinant of individual differences in teacher stress.

The mean ratings of the stressfulness of the 51 sources of stress indicate that the major sources of stress cover a number of diverse aspects of the teacher's job. However, the presentation of the items in descending order of means in Table 2 should be treated only as a crude guide to their relative importance in view of the relative size of the standard deviations in comparison with the size of the differences in means. It should also be noted that not all sources of stress apply to all teachers (e.g. mixed-ability classes, non-exam final-year pupils). Thus the degree of stressfulness associated with these items is probably greater for those teachers to whom these items apply than is indicated by the mean ratings of stressfulness based on the total sample of teachers.

The principal components analysis of the sources of stress indicated that these may be described largely in terms of four orthogonal factors: ' pupil misbehaviour ', ' poor working conditions ', ' time pressures ', and ' poor school ethos '. This finding supports work elsewhere (e.g. Coburn and Jovaisas, 1975; Rogers, 1977), indicating that sources of stress are multidimensional rather than unidimensional.

The numerous differences for biographical subgroups in the importance of the sources of stress indicate that although there appear to be no significant differences in the overall level of self-reported stress for these subgroups, the major sources of stress that contribute to the overall level may be composed somewhat differently. It should also be noted that a teacher need find only one aspect of his job extremely stressful, perhaps one not considered by most teachers as a source of stress and hence not employed in this study, for him to nevertheless rate his overall level of stress as extreme.

The mean ratings of the 17 symptoms of stress indicate that feeling ' exhausted ' and ' frustrated ' are the most common symptoms experienced. The loadings on the first (unrotated) factor, however, indicate that the symptom (other than feeling ' under stress ') contributing most to the ' awareness of stress symptoms ' is feeling ' very tense '. This finding supports the formulation of Frankenhaeuser and Gardell (1976) who argued that the higher levels of arousal associated with stress reactions will be experienced primarily as excessive tension.

Finally, the single-item measure of self-reported teacher stress appears to have a high degree of validity within the context of the questionnaire employed, since the ratings of all 51 sources of stress and 17 symptoms of stress correlated significantly and positively with this measure. Nevertheless, there is a need for further research to establish its empirical validity, particularly in relation to the response correlates of teacher stress that have been outlined by Kyriacou and Sutcliffe (1978).

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SOME FACTORS AFFECTING DOCILITY IN PRIMARY SCHOOL CHILDREN

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SUMMARY. The relationship between docility and age, sex, and the social structure of the school and the family is examined for a sample of 1184 children in primary schools of differing social structure. Two docility measures were developed, based on the notions of an uncritical accepting attitude towards the pronouncements of authority figures, a disposition to obey instructions without regard to their merit, and a tendency to condemn behaviour which is openly critical of authority figures. Correlation and regression analyses of the data show, firstly, that age is the most important variable affecting docility, correlating negatively with it; secondly, that social class is next in importance, also correlating negatively with docility; and thirdly, that there are additional small relationships between docility and sex, and between docility and school social structure. Taken together, the variables used here account for approximately 20 per cent of the variance between children in docility levels.

INTRODUCTION

THIS paper reports research into some of the factors affecting docility in primary school children. Specifically the effects on docility of age and sex are investigated, together with the effects of the social structure of the school and of the family. The research is set in the context of an increasing concern in the literature about the general affective consequences of the schooling process. This literature is, however, mostly lacking in empirical evidence. What little evidence is reported usually has observation as its basic method, sometimes by an external observer (for example, Henry, 1955, 1957) but frequently by participant observers—usually teachers in their classrooms (for example, Holt, 1964; Kohl, 1972). In a comprehensive review of research into the effects of schooling, Averch *et al.* (1971) included a section on the 'reform writers'; while the reviewers saw sufficient agreement among such writers to give their ideas some credibility, they pointed out the need for more objectively based empirical research in the area.

The literature on docility and schooling does hold a consensus that docile behaviour occurs in the classroom, and that a certain amount of conformity and associated docile behaviour is necessary to get school work done in a structured way. Its more serious accusations are that, to make children manageable, schools press them into a 'homogeneous docility' to such an extent that the docile attitudes and behaviour extend out of school time, and beyond the school years (see, for example, Henry, 1963; Goodman, 1964; Holt, 1964; Friedenberg, 1970; Silberman, 1970). The precise meaning of the term docility is often not made clear by the different writers, but a survey of their work indicates that docility includes three basic notions: (a) an uncritical accepting attitude towards the pronouncements of authority figures; (b) a disposition to obey instructions without regard to their merit; and (c) a tendency to condemn the behaviour of anyone who is openly critical of authority figures. This is the general definition of docility used in this study. It suggests that the factors affecting docility will be those which affect the child's interactions with authority figures. This paper considers three such factors—the social structure of the school, the social structure of the family, and the age and sex of the child. The aspects of the social structure of the school to be investigated are its size, and the child-adult ratio and the level of age homogeneity in its instructional groups. The aspects of the social structure of the family are its size, social status, and its educational, religious, and ethnic backgrounds.

METHOD

The dependent variable—docility—was measured by two 16-item summated rating instruments specifically developed for this study on the basis of the three-part definition of docility given earlier. The first measure, a scale, required children to indicate the extent of their agreement or disagreement, using the typical five-point response format, with 16 statements. Some of the statements were positively worded, and some negatively, but all pertained to docile attitudes towards authority figures, in either in-school or out-of-school situations. The second measure, a story, required a similar response, but the 16 statements here were based on a short story about docile and non-docile children. Each item was worded to permit identification by the subject with characters in the story. The two instruments were developed from large pools of items, and each was taken through several rounds of pretesting. Alpha reliability estimates averaged ·88 across the different pretest administrations of the scale, and ·93 across the pretest administrations of the story. Test-retest reliability estimates, based on a six weeks' interval, were ·81 for the scale and ·82 for the story. Validation against teacher ratings of children's docility showed that items, subscales and totals also differentiated effectively between high and low comparison groups.

The variable school social structure was based on a classification of schools. In Western Australia, primary school educational settings vary considerably in their social structure, ranging from one-teacher schools with eight children to schools with over 700 children and more than 20 teachers. In order to take account of this variability, schools for this study were divided into two groups. Small schools were defined as those with enrolments of between eight and 120 children; they have classrooms with an average child-adult ratio of 23 : 1, and are age heterogeneous, with two or more grade levels in the classroom. Large schools, with enrolments of more than 120 children, have an average child-adult ratio of 36 : 1, and only one grade in their age-homogeneous classrooms. Only children from grades five, six, and seven, the last three years of primary schooling, were selected for the study. The age of the child was collected, and used also as a measure of his length of schooling.

Information about the variables relating to family structure was collected from a questionnaire to parents. Family size was defined by the number of children in the family, parents' religions were classified into six groups—Anglican, Methodist, Presbyterian, Roman Catholic, ' other ', or ' no religion ' and each parent's nationality was taken as the country of birth. The educational background of each parent was measured on an eight-point scale, from ' attended three years of secondary school or less ', to ' attended university and completed a degree '. Father's occupational prestige was measured on a 16-point rating scale developed for Australian conditions (Broom and Jones, 1969).

The sample in the analyses of the main study comprised 1184 children from grades five, six, and seven. This represents the 82 per cent of the original sample of 1440 children from whom complete data, including parent information, were sought. They were drawn from 25 small schools, mostly in rural areas, 12 large rural schools, and 20 large metropolitan schools. The 20 metropolitan schools were approximately equally drawn from low, middle, and high socio-economic areas.

RESULTS

Preliminary analysis of the data dealt with the measures of docility, and especially with their dimensionality. For both measures, the correlation matrix showed substantial common variance between items from different facets of the definition. In other words, despite the procedures followed in scale construction, the three facets of the definition were not clearly distinguishable in the pattern of responses. This was confirmed by factor analyses of the two measures, both separately and jointly. Six first order components with eigenvalues greater than unity emerged from a joint analysis of the scale and story measures. After an oblique (oblimin) rotation with δ set at 0·475 (Nie *et al.*, 1970, p. 225) a second order analysis produced one component with an eigenvalue greater than unity, accounting alone for 75·8 per cent of the variance in the first order components. A factor score on this first general component of the second order analysis was computed for each student, and used as the measure of docility in subsequent analysis. These factor scores have a mean of zero, unit variance, and are positively scored.

School Social Structure, Age, Sex, and Docility

The results of the bivariate analyses for the effects of school social structure, age, and sex of child on docility are set out in Table 1. In each case, a statistically significant relationship exists. The results for school social structure indicate that children in small schools with low child-adult ratio and age heterogeneous classrooms seem to be more docile than children in large schools. With respect to age, older children are less docile than younger children, the scores for the three age groups showing a consistent and almost linear trend. The effect of sex, with girls significantly more docile than boys, is in line with an apparent societal expectation for girls to be less independent and more conforming than boys.

TABLE 1

MEAN DOCILITY SCORES FOR SCHOOL TYPE, AGE, AND SEX CATEGORIES

	N	Mean Score	F-ratio	P<
Type of School				
Large	1008	−0·07	15·58	0·01
Small	176	0·25		
Age				
Grade Five	360	0·45	80·83	0·01
Grade Six	352	0·01		
Grade Seven	472	−0·37		
Sex				
Boy	570	−0·13	18·68	0·01
Girl	614	0·12		

The joint effects on docility of the three variables school social structure, age, and sex are set out in Table 2. There is no significant triple interaction ($F = 2{\cdot}80$, $P > 0{\cdot}05$) nor is there significant interaction between sex and school structure ($F = 0{\cdot}20$, $P > 0{\cdot}05$), or between sex and age ($F = 2{\cdot}52$, $P > 0{\cdot}05$). But the interaction between age and school social structure is significant ($F = 8{\cdot}48$, $P < 0{\cdot}01$). This is due to the relatively low docility of the grade six students, especially the girls, in the small schools. If the result for the grade six girls is temporarily ignored, the combined results for age, sex, and school social structure suggest three generalisations. First, within each sex group and school size, there is a monotonic decrease in docility with age. Second, within each grade, children in small schools are more docile than children in large schools. Third, within each school grouping, girls are more docile than boys. The grade six girls in the small schools fit none of these generalisations, as they are the least docile group in this grade, and even less docile than the grade seven children in these small schools. Another interesting result is the relatively high docility level of this latter group. Also, the grade seven children in the small schools are more docile, compared with the grade seven children in the large schools, than might be expected, given the pattern of the other results.

TABLE 2

MEAN DOCILITY SCORES OF BOYS AND GIRLS OF GRADES FIVE, SIX, AND SEVEN IN SCHOOLS OF DIFFERENT SOCIAL STRUCTURE

		Grade 5 (N)	Grade 6 (N)	Grade 7 (N)
Large schools	Boys	·25 (140)	−·18 (146)	−·56 (192)
	Girls	·54 (159)	·16 (163)	−·39 (208)
Small schools	Boys	·43 (32)	·13 (20)	·03 (40)
	Girls	·82 (29)	−·26 (23)	·30 (32)

(F=19·77, P<·01)

Family Structure and Docility

Two of the family structure variables show no significant relationship with docility. Size of family correlates only 0·04 (P>0·05) with docility. However, as Table 3 shows, substantial deviations from the overall mean score of zero occur in the single child, and the very large families. The low average docility level of the only child is also interesting, despite the small number of such cases. The other family variable to show no relationship with docility is the nationality of the parents. Table 3 shows that there is a slight tendency for the less docile children to have Australian-born parents. Separate analysis of each parent's nationality supports this trend, and suggests that the nationality of the mother has a stronger influence than that of the father—this effect almost reaches statistical significance at the 0·05 level. The effect of parents' religion is strongest when both parents' religions are considered together. These results are also shown in Table 3. The effect of each parent's

TABLE 3

MEAN DOCILITY SCORES FOR SIZE OF FAMILY, NATIONALITY, AND RELIGION CATEGORIES

	N	Mean Score	F-ratio	P<
Size of Family				
One child	20	−0·22	1·90	0·05
Two children	229	0·01		
Three or four children	717	−0·03		
Five or more children	218	0·13		
Birth Place of Parents				
Both Australian	814	−0·03	1·48	0·05
Father Australian, mother not	59	0·22		
Mother Australian, father not	89	0·02		
Neither Australian	222	0·05		
Religion of Parents				
Both Anglican	396	−0·10	2·27	0·05
Both Methodist	78	0·11		
Both Presbyterian	41	−0·04		
Both Roman Catholic	125	0·08		
Both ' other ' religion	75	0·16		
Both of no religion	19	−0·49		
Both have different religions	450	0·04		

religion considered separately did not reach statistical significance, but, as for nationality, there seems to be a stronger effect associated with the mother's religion.

The family variables related to social class correlate positively with each other, and negatively and significantly (P < ·01) with docility. The correlations suggest that higher levels of docility are associated with lower educational background and occupational prestige of parents, but a clearer picture of the relationships is given by Table 4. These tables show results with the eight-point scale for educational background collapsed to four points, and the 16-point Broom and Jones Occupational Rating Scale collapsed to six points (Jones and Jones, 1972, p. 76), because of the very small numbers in some categories. There is a consistent trend towards low docility in children whose parents have had more education, and again the suggestion that the background of the mother may be the stronger influence. The relationship between occupational prestige and docility is not strictly linear. Rather there is a tendency for higher docility in blue collar workers and lower docility for others. These data, in other words, would not appear to support Henry's (1955) contention that docility is a middle-class phenomenon. The variance held in common between mother's and father's educational background (r = ·51, P < ·01), and between educational background and occupational status (r = ·42, P < ·01), suggests that some combination of these variables might be used as a single index of social class. In fact a simple unweighted sum of scores on the three scales correlates as well with docility (r = − ·15, P < ·01) as other more complicated composite measures.

TABLE 4

MEAN DOCILITY SCORES FOR EDUCATIONAL BACKGROUND AND OCCUPATIONAL PRESTIGE CATEGORIES

Parent's Education	Up to four years of secondary schooling (N)	Up to four years plus job training (N)	Five years with or without job training (N)	Attended University (N)	F-ratio	P<
Mother	·02 (650)	− ·02 (351)	− ·15 (131)	− ·60 (52)	7·99	·01
Father	·10 (617)	− ·12 (359)	− ·16 (105)	− ·26 (103)	6·91	·01

Occupation categories	Prof. (1-3)	Manag. (4-6)	White Coll. (7-8)	Skill. Man. (9)	Semi-Sk. Man. (10-12)	Unskill. Man. (13-16)	F-ratio	P<
	− ·09 (261)	− ·17 (204)	− ·13 (186)	·14 (245)	·13 (148)	·06 (140)	3·84	·01

Joint Effects of Factors Affecting Docility

The joint effects of the school, age, sex, and family variables were examined using a backward-stepping multiple regression procedure. Because of their interaction, the age and school social structure variables were considered conjointly. Four family structure variables were entered into the full model—size of family was taken as a continuous variable, parents' nationalities and parents' religions were considered categorically, using the categories shown in Table 3, and a single index of social class was used to replace the variables of parents' educational backgrounds and father's occupation. Based on the results of earlier analyses, an *a priori* order of removal of the variables from the full prediction model was used in the backward-stepping analysis. This order of removal gave the smallest successive decreases in the squared multiple correlation coefficient. The results are shown in Table 5.

TABLE 5

JOINT EFFECTS OF FACTORS AFFECTING DOCILITY

Predictor Variables in Regression Analysis	R^2 of model containing variable and all those below it	Test of significance of loss in R^2 when preceding variable is removed	P
Size of family	0·1917		
Parents' nationalities	0·1905	F=1·66	>0·05
Parents' religions	0·1860	F=3·22	<0·05
Social class	0·1786	F=1·78	>0·05
Sex of child	0·1514	F=39·02	<0·01
Age/school social structure	0·1368	F=20·20	<0·01

Removal of the variables concerned with size of family and parents' religions does not cause a statistically significant decrease in the value of R^2, indicating that these variables do not explain significant amounts of the variance in children's docility scores, over and above that explained by other variables in the model. While Table 5 shows that knowledge of parents' nationalities accounted for sufficient variance in docility scores just to reach statistical significance at the 0·05 level, this was not always the case when other orders of removal were used. It seems unlikely, therefore, that parents' nationalities make an important contribution to the prediction of docility scores over and above the contributions of social class, sex of child, and the age/school social structure variables in combination. This latter group of variables accounts for 17·86 per cent of the variance in docility scores.

Relative Importance of Factors Significantly Affecting Docility

The relative importance of the four factors found significantly to affect docility scores in primary school children was determined by partitioning sums of squares in an analysis of variance. This was done using multiple regression in the ' step-down analysis ' procedure described by Overall and Klett (1972, p. 449). Social class, the only continuous variable, was entered first into the model and treated as a covariate. Age, sex, and school social structure were then entered, followed by the age/school structure interaction, the other lower order interactions, and finally the higher order interaction between these variables. The results of this analysis are set out in Table 6.

The findings of the investigation are summarised by these results of the partitioning of sums of squares. Age is the most important single variable to affect docility in primary school children and accounts for about 12 per cent of variance in docility scores. Social class, the only family structure variable found to have a significant effect, is next in importance, accounting for just over 2 per cent of the variance. Sex, school social structure, and the interaction between school social structure and age each contribute a little over 1 per cent of the variance in docility scores. The other interaction effects are not statistically significant.

DISCUSSION

According to these results, age is the most important single factor affecting docility in primary school children, accounting alone for over 12 per cent of the variance in docility scores. The relationship is negative—younger children show higher docility levels than older children. This negative relationship suggests either that docility levels decrease as a consequence of maturation, or that attendance at school helps children become less docile. It is not possible completely to separate the effects of maturation from schooling, but the fact that children in different types of schools have different levels of docility tends to indicate that maturation is not the sole reason for the relatively strong age effect. By contrast, the variation in levels of

TABLE 6

Stepdown Analysis to Partition Sums of Squares

Source (in order of entry into model)	Increase in R^2	Sum of Squares	Degrees of Freedom	Mean Square	F-ratio	P<
Covariate:						
Social class	·0212	24·97	1	24·97	30·37	·01
Main Effects:						
Age	·1218	143·43	2	71·72	87·26	·01
Sex	·0122	14·37	1	14·37	17·48	·01
Type of school	·0114	13·42	1	13·42	16·33	·01
Interaction Effects:						
Age × type of school	·0120	14·13	2	7·07	8·60	·01
Age × sex	·0005	·59	2	·29	0·36	·05
Sex × type of school	·0000	·00	1	0·00	0·00	·05
Age × sex × type of school	·0036	4·24	2	2·12	2·58	·05
' Error '	·8173*	962·46	1171	·82		
Total		1177·62	1183			

* This value for ' error ' was obtained by subtracting from unity the R^2 value of ·1827 obtained for the full model (comprising covariate, main effects, and interaction effects).

docility attributable to school social structure is little more than 1 per cent. It is possible that even this small amount of variance is not due entirely to school social structure, but to other variables block-booked with size of school. Examples of such variables might include the attitudes of the individual classroom teachers—whose personal influence may be greater in the small schools than in the large—and environmental factors associated with the geographic location of schools.

These results regarding age and the social structure of the school need to be set against the frequent allegation in the literature that schools ' make students docile '. It might be inferred from this that the larger, more ' institutionalised ' schools, with high child-adult ratios and age-homogeneous classrooms, would encourage the development of higher levels of docility in their pupils than would smaller schools. No evidence has been found here to support this inference. Although school social structure, in numerical terms, has only a small relationship with docility, children with more docile attitudes are found in small schools with age-heterogeneous classrooms and a low ratio of children to adults. Further, children seem to become less docile as they grow older, so that attendance at school, at least until the end of primary school, does not seem to result in increasing attitudes of docility. The apparent dissonance between these results and the claims of such critics as Henry (1955), Holt (1964), Goodman (1964), and Silberman (1970), should be tempered by the consideration that this study measured docility as an ' attitude ', or disposition to behave in a certain way. At the same time, while much of the critical literature describes docile behaviour *per se*, docile ' attitudes ' are very often implied.

A possible reason for the strong age effect is suggested by the nature of docility itself. The child who is docile, in terms of the definition used here, will tend to rely on authority figures for assistance in decision-making, and also for support and approval. The adult authority figures with whom the child first forms dependent relationships are his parents, and, later, other adults, including his teacher. As the child grows older, he typically develops more co-operative interaction patterns, and more stable bonds of friendship with peers (Roberts, 1971; Hurlock, 1972). This may well be associated with decreased dependence on adult authority figures and increased dependence on support from peers. If this is so, docility will decrease with age, and this decrease will be most rapid in those situations—such as large schools, with high child-adult ratios, and age-homogeneous classrooms—which encourage independence in children. The present findings relating to the sex and social class of the child are consistent with this reasoning. Girls are more docile than boys, in line with a cultural expectation that boys should be more independent. The lower docility of the middle-class children might be explained by the tendency of these parents to encourage self-direction in their children (Kohn, 1963). Again, Roberts (1971) has described how lower-class children are often not accepted readily into groups by classmates, thus making it more difficult for these children to form supportive relationships with their peers.

These points, when taken together with the results of this study, suggest three areas for further research with primary school children. The first concerns the dependent variable itself. More needs to be learned about the nature of docility, and, in particular, about the association between docile attitudes and docile behaviour. The second area concerns the variables relating to family structure. The strongest effect found here is the negative relationship between social class and docility, although social class accounts for only a little more than 2 per cent of the variance in docility scores. Perhaps, therefore, future research into the effects of family variables on children's attitudes should take less of a structural emphasis than was taken here. In particular, there is a need for investigation of the influence of process and attitudinal variables in the home on children's affective development. Thirdly, further research should investigate additional variables as possible determinants of docility levels. In the school, as in the home, process and attitudinal variables are likely to be important. And, in the case of both home and school, patterns of social interaction with adults and peers may have significant influences on children's docility levels.

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ATTITUDINAL CORRELATES OF ACADEMIC ACHIEVEMENT IN ELEMENTARY SCHOOL CHILDREN

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SUMMARY. The relationship between three levels of academic achievement and various attitudinal variables was investigated. Using the regression equation method, a sample of 275 male and 263 female grade six elementary school children were assigned to an under-achieving, average-achieving, or over-achieving group. The children completed three attitude tests, and the items which discriminated between the three groups were subjected to factor analysis. For the boys five factors were identified, and for the girls four. Subsequently, the average-achieving subjects, males as well as females, were subdivided in terms of intelligence into three groups, and the items which discriminated between these subgroups were subjected to factor analysis. Twelve factors were identified for the boys and five for the girls, indicating that the average-achievers do not constitute a homogeneous group with regard to the attitudinal correlates of academic achievement. These correlates vary apparently not only as a function of level of academic achievement, but as a combined function of level of academic achievement and intelligence.

INTRODUCTION

SEVERAL recent studies on the correlates of academic achievement at the high school and university levels (Banreti-Fuchs, 1972, 1975; Banreti-Fuchs and Meadows, 1976) have demonstrated significant relationships between various attitudinal, situational, and mental health factors on the one hand, and levels of academic achievement on the other. The results of these studies did not support the claims of Furneaux (1962), and Kelvin *et al.* (1965) that there was a positive relationship between neuroticism and academic achievement. However, the personality picture of the achievers did confirm the findings of Lavin (1965), Entwistle and Entwistle (1970), Entwistle and Brennan (1971), and Entwistle (1972), who had described achievers as essentially stable introverts. The results were also quite consistent with the findings of Davids *et al.* (1968), Desiderato and Koskinen (1969), Spielberger (1966), Barton *et al.* (1974), and Kohn and Rosman (1974) on the negative effects of anxiety and emotional instability with regard to academic achievement.

In the present study, grade six elementary school children were chosen as our experimental subjects. This enables us to form an impression whether the attitudinal correlates of academic achievement at this age level are drastically different from those at the high school and the university levels. The possibility of such a comparison could be interesting, since a number of investigators have found indications of differences in personality correlates when comparing two age levels. Orpen (1976) examined a 14-year-old and a 20-year-old group and found that academic success was related to stable extraversion in the former, and to introversion in the latter group. Similar results were also reported by Ridding (1967), Honess and Kline (1974), and Stedman and Adams (1972). Another aspect of this project is the examination of potential sex differences by processing the data for the boys and the girls separately. This is important since Entwistle and Cunningham (1968), in a large-scale study with 13-year-old children, found that extraverted girls but introverted boys tended to be more successful academically. The main objective of this study, however, is to explore whether there is a relationship between the attitudinal correlates of academic achievement within a certain achievement group, e.g., the average-achievers, and the intellectual level of the subjects. In other words, are the attitudinal correlates of academic achievement in average-achievers of high-intelligence the same as in average-achievers of average, or low, intelligence? An analogous question with regard to anxiety was tackled by Spielberger (1966), who demonstrated that the effect of anxiety on level of performance was different in people of low, average, and high intelligence levels.

METHOD

A sample of 275 grade six boys and 263 girls from 13 elementary schools under the jurisdiction of the Calgary Board of Education were involved in this project. All children were administered the Student Interest and Attitude Study III (S) (Banreti-Fuchs, 1976b), the Revised Piers-Harris Self-Concept Scale (P) (Banreti-Fuchs, 1976a), and the Frost Self Description Questionnaire (F). The Research Office of the Calgary Board of Education provided the following data on each child: (1) Verbal and Non-verbal raw scores on the Canadian Lorge-Thorndike Intelligence Test, Form 1; (2) Reading Comprehension raw scores on the Stanford Reading Test, Intermediate II, Form Y (1964); (3) Level 4 Mathematics raw scores on the Canadian Test of Basic Skills (1970). These intelligence and achievement tests had been administered by the school system prior to our administration of the three attitude tests. After the completion of all testing, the subjects were classified as under-, average-, or over-achievers. The test results of the boys and the girls were analysed separately throughout the project. Assignment to one of the three achievement groups was based upon the regression equation method (Guilford, 1956), using the subjects' verbal *plus* non-verbal intelligence raw scores (VPI) and their combined achievement test raw scores on reading *plus* mathematics (RM). Those children whose actual RM scores were between plus and minus 0·7 standard error of estimate from their expected RM scores, were classified as average-achievers (A). Children whose actual RM scores were 0·7 standard error of estimate or more above their expected RM scores, were classified as over-achievers (0), while children whose actual RM scores were 0·7 standard error of estimate or more below their expected RM scores, were classified as under-achievers (U). A standard error of estimate of 0·7 was used in order to conform to the procedures employed by the author in his previous projects on academic achievement, so the results would be more comparable.

Item analysis was carried out on the responses of the three achievement groups (O, A, U) to all items of the Student Interest and Attitude Study III, the Revised Piers-Harris Self-Concept Scale, and the Frost Self Description Questionnaire. Only those items which discriminated significantly ($P \leq 0 \cdot 05$ two-tailed) between the over-, average-, and under-achieving groups in a systematic manner, i.e., with the O and U groups at the two ends of the response distribution and the A group in between these two, were subjected to factor analysis using the principal component solution and the varimax rotation method (Kaiser, 1958). In deciding which items to include in the interpretation of the factors, a factor loading of ±0·40 was chosen as the cut-off score, in order to conform to the standards set in the previous studies on academic achievement by the author (Banreti-Fuchs, 1972, 1975; Banreti-Fuchs and Meadows, 1976).

The main objective of this project was the investigation of the relationship between intelligence and the attitudinal correlates of academic achievement within a specific achievement level, the group of average-achievers. Therefore, the average-achievers were divided into three subgroups: (a) high-intelligent average-achievers (HI); (b) average-intelligent average-achievers (AI); and (c) low-intelligent average-achievers (LI). Subsequently an item analysis was carried out on the responses of the HI, AI, and LI groups to all items of the three attitude tests (S, P, and F) used in this project. Those items which discriminated significantly ($P \leq 0 \cdot 05$ two-tailed) between the HI, AI, and LI groups in a systematic manner, were subjected to factor analysis using the same methods and standards as described previously. Again the data for the boys and girls were analysed separately.

An important methodological issue should be pointed out here for the sake of complete clarity. Since the method of considering each item separately may result in a number of items reaching statistical 'significance' on the basis of chance alone, it should be understood clearly that only those significant items which discriminated between the three groups (A, O, U; and HI, AI, LI) in a systematic manner were used in the factor analyses. Systematic means that, in terms of average value, the scores of the over- and under-achieving groups had to be at the two ends of the response distribution and the average-achievers in between these two. This additional requirement reduces the number of discriminating items whose 'significance' may be based on chance alone by two-thirds.

RESULTS AND DISCUSSION

The Pearson product-moment correlation between the intelligence test raw scores (Canadian Lorge-Thorndike, verbal *plus* performance) and the combined achievement test raw scores (Reading *plus* Mathematics) resulted in $r = 0{\cdot}82$ for the males, and $r = 0{\cdot}80$ for the females ($P < 0{\cdot}001$).

Male Sample

Based on the regression-equation method (Guilford, 1956), 56 subjects were classified as under-achievers, 159 as average-achievers, and 60 as over-achievers (Table 1). As expected, the three achievement groups did not differ significantly in average age or intelligence, but were significantly different in average achievement test scores.

TABLE 1

MEAN AGE, INTELLIGENCE, AND ACADEMIC ACHIEVEMENT SCORES OF THE UNDER-, AVERAGE-, AND OVER-ACHIEVING MALES AND FEMALES

Variables	Sex	Under Achievers		Average Achievers		Over Achievers		P*
	M F	N=56 N=58		N=159 N=140		N=60 N=65		
		Mean	SD	Mean	SD	Mean	SD	
Age	M	11·82	0·39	11·87	0·51	11·87	0·54	NS
	F	11·78	0·53	11·79	0·45	11·89	0·36	NS
Intelligence	M	102·48	18·61	102·75	25·55	102·95	20·37	NS
	F	98·90	16·52	100·59	23·04	100·69	27·35	NS
Academic achievement	M	48·84	14·21	64·14	17·28	77·05	13·53	0·000
	F	47·84	11·91	62·88	14·34	75·55	16·30	0·000

* Analysis of variance.

Item analysis revealed that 13 items discriminated significantly and systematically between the under-, average-, and over-achievers (Table 2). Factor analysis indicated five factors which account for 53·5 per cent of the variance.

Factor 1 accounts for 14·4 per cent of the variance and identifies attitudes related to frustration. Under-achievers tend to feel more tired and sleepy during the day, feel that their parents nag more, find it hard to keep their minds on a test, and generally prefer to watch TV rather than read.

TABLE 2

ROTATED FACTOR MATRIX OF THE DISCRIMINATING ITEMS FOR THE UNDER-, AVERAGE-, AND OVER-ACHIEVING MALES

		Factors					
Items	Item No.	1	2	3	4	5	h^2
Tiredness	S 10	*·49*	−·04	·32	·16	−·06	·37
School regulations	S 18	·05	·02	−·04	−*·82*	·17	·71
Freedom	S 21	·19	−*·50*	−·23	·33	−·01	·45
Parents nag	S 59	*·51*	·10	·06	−·11	·28	·36
Popularity	P 57	·15	−·23	*·73*	·06	·24	·67
Disappointment	P 59	−·15	·19	*·73*	−·01	−·08	·60
Concentration	F 3	*·43*	·21	·08	·27	·33	·42
Shortchanging parents	F 5	·07	−·07	·07	−·05	*·74*	·56
Watching TV	F 85	*·71*	·02	−·21	·07	−·10	·56
Teachers dislike	F 88	·18	·08	·00	*·57*	·33	·47
Mechanic	F 90	·35	*·64*	−·17	−·05	−·05	·57
Factory work	F 97	·03	*·73*	−·01	·19	·03	·57
Volley-ball	F 107	−·35	·11	−*·45*	·20	*·51*	·64
Percentage of variance:		14·4	12·0	10·3	8·7	8·1	

Total variance accounted for: 53·5%

Factor 2 accounts for 12·0 per cent of the variance and identifies attitudes related to ambition and constraint. Under-achievers tend to feel that the average teenager should have more freedom and independence, and they are more likely to be sympathetic toward the idea of being engaged in manual labour and factory work when they grow up.

Factor 3 accounts for 10·3 per cent of the variance and identifies attitudes related to social acceptance. Under-achievers tend to feel that they are more popular with the other boys, they have the impression that their families are satisfied with them, and consider volley-ball as one of their favourite games.

Factor 4 accounts for 8·7 per cent of the variance and identifies attitudes toward the school milieu. Under-achievers tend to feel that the present school rules and regulations are too strict, and that they would be doing better in school if the teachers did not dislike them so much.

Factor 5 accounts for 8·1 per cent of the variance and identifies attitudes toward activity. Under-achievers consider volley-ball as their favourite activity, and they tend to feel that they are not doing enough for their parents.

Although a direct comparison of the results of this factor analysis with those of the author's previous three projects on academic achievement (Banreti-Fuchs, 1972, 1975; Banreti-Fuchs and Meadows, 1976) is impossible since the test instruments had to be adjusted to the different age levels of the subjects involved in the various projects, nevertheless certain tentative observations can be made. Reviewing the five factors, it seems justifiable to conclude that the male under-achievers at the grade six level (1) are generally rather frustrated individuals, (2) have relatively little ambition, (3) do not consider themselves socially alienated, (4) tend to dislike the school milieu, and (5) are more non-academically oriented. These are all characteristics which, in some form, we have also found at the high school as well as university levels.

Subdividing the average-achieving male sample into three groups of different intelligence levels resulted in 53 low-intelligent average-achievers (LI), 52 average-intelligent average-achievers (AI), and 54 high-intelligent average-achievers (HI). The

TABLE 3

MEAN AGE, INTELLIGENCE, AND ACADEMIC ACHIEVEMENT SCORES OF THE AVERAGE-ACHIEVING LOW-, AVERAGE-, AND HIGH-INTELLIGENT MALES AND FEMALES

	Sex	Low Intelligence		Average Intelligence		High Intelligence		
Variables	M F	N=53 N=45		N=52 N=49		N=54 N=46		P*
		Mean	SD	Mean	SD	Mean	SD	
Age	M	11·94	0·60	11·85	0·50	11·83	0·42	NS
	F	11·87	0·46	11·71	0·46	11·78	0·42	NS
Intelligence	M	73·30	14·23	105·04	7·52	129·46	9·71	0·000
	F	74·62	12·53	100·59	7·48	125·98	9·68	0·000
Academic achievement	M	44·96	9·90	64·71	6·02	82·43	7·12	0·000
	F	47·40	8·09	63·22	6·51	77·65	7·96	0·000

* Analysis of variance.

three groups did not differ significantly in age, but were quite different in intelligence and level of academic achievement (Table 3). Item analysis of their responses to the three attitude tests (S, P, and F) revealed 37 items discriminating significantly and systematically between the low-intelligent, average-intelligent, and high-intelligent average-achievers (Table 4). Factor analysis of the discriminating items indicated twelve factors accounting for 62·4 per cent of the variance.

Factor 1 accounts for 16·6 per cent of the variance and identifies feelings related to success and accomplishment. Low-intelligent average-achievers (LI) perceive themselves as less successful, less bright, less attractive, less self-controlled, and less well-behaved.

Factor 2 accounts for 7·2 per cent of the variance and identifies feelings related to helplessness and failure. LI tend to feel that they are less intelligent, give up more easily, are more unhappy and clumsy, and have a poorer relationship with their parents.

Factor 3 accounts for 6·0 per cent of the variance and identifies feelings related to drive and satisfaction. LI tend to perceive themselves as less active in the classroom, and less ambitious, more nervous, and less happy being the way they are.

Factor 4 accounts for 4·6 per cent of the variance and identifies attitudes toward manual labour as well as feelings of tension. LI reject the prospect of manual labour as a career to a somewhat lesser extent, and perceive themselves as tense to a greater extent than the average-, and high-intelligent average-achievers.

Factor 5 accounts for 4·2 per cent of the variance and identifies attitudes toward school. LI tend to become more nervous when called upon by the teacher in the classroom, and worry more about school in general.

Factor 6 accounts for 4·0 per cent of the variance and identifies attitudes related to mental health. LI tend to worry more, are more frequently angry with other people, have more often the feeling that something bad is going to happen, and complain more about other children.

Factor 7 accounts for 3·6 per cent of the variance and identifies attitudes regarding

TABLE 4

ROTATED FACTOR MATRIX OF THE DISCRIMINATING ITEMS FOR THE AVERAGE-ACHIEVING LOW-, AVERAGE-, AND HIGH-INTELLIGENT MALES

Items	Item No.	Factors												
		1	2	3	4	5	6	7	8	9	10	11	12	h²
Cultural activities	S 11	−·08	−·02	·05	−·04	·05	·02	·02	*·78*	·02	·11	·00	−·08	·64
School regulations	S 18	−·11	·05	−·01	−·05	·01	−·20	·01	·30	−·26	*·60*	·02	−·02	·58
Homework finished	S 34	−·07	−·18	−·03	−·06	−·15	·14	−·17	·08	−·03	*·60*	−·09	·04	·49
Detentions	S 38	−·34	−·08	·05	·05	·02	−·12	·03	−·25	·25	*·59*	−·08	−·14	·64
Volunteering	S 39	−·15	−·08	*−·67*	−·00	·10	·14	−·15	·07	−·02	−·08	−·06	−·08	·55
Attention	S 40	*−·61*	−·07	−·16	−·06	·27	−·11	−·09	·14	·07	−·00	−·09	·02	·60
Ambition	S 42	·13	·02	*·47*	·15	·17	−·01	*·61*	−·12	−·06	−·09	·10	−·17	·73
Punishment	S 57	·05	·20	−·29	·35	·26	−·01	*·52*	−·04	·08	·24	·03	·10	·66
Parents nag	S 59	·17	*·51*	·04	·34	·30	·17	·02	·12	·24	·18	−·01	·13	·65
Intelligent	P 5	·20	*·74*	·09	−·05	·09	−·09	·16	·06	−·01	·08	·04	·17	·68
Nervous	P 7	−·04	·16	−·03	−·01	*·74*	·05	·18	−·15	−·12	−·03	·01	−·12	·66
Well behaved	P 12	*·58*	·35	·14	·01	−·04	−·15	·04	·06	·20	−·22	−·05	·20	·64
Giving up	P 20	·18	*·79*	·08	−·06	·00	·07	·15	−·08	·02	−·10	·07	−·03	·72
Homework	P 26	·18	·39	·04	·11	·37	·08	−·15	−·14	*−·42*	−·05	−·17	−·23	·64
Nervousness	P 28	·14	·19	*·58*	·15	·27	·14	·07	·04	−·17	−·02	·10	·03	·55
Pretty eyes	P 29	*·59*	−·01	−·00	·37	·03	·13	·05	−·01	−·01	−·15	·09	−·29	·62
Daydreaming	P 31	*·67*	·08	·06	−·11	·27	·06	·03	·00	·27	−·25	·07	·17	·72
Self satisfaction	P 39	·07	·32	*·63*	·05	−·09	·11	−·08	·11	·22	−·09	·06	·02	·61
Volunteering	P 42	·28	·26	·16	−·02	·00	·08	·20	−·25	*·51*	−·26	·28	·10	·70
Unhappy	P 50	−·04	*·52*	·12	·33	−·02	·12	·15	·05	·20	−·13	−·13	−·33	·62
Dumb	P 53	*·55*	·09	·02	·16	−·00	−·00	·07	·04	·38	−·06	·00	·33	·60
Lack of luck	P 61	*·62*	·27	·17	−·11	·03	·17	·09	−·14	−·09	·04	·20	−·09	·61
Clumsiness	P 64	·02	*·68*	·22	·02	·09	−·06	−·08	−·08	·03	−·22	·20	·15	·65
Concentration	F 3	·16	·17	−·07	·22	−·19	·38	·07	·01	−·12	−·01	*·55*	·16	·64
Tactfulness	F 17	−·12	−·10	·01	·18	·13	·09	·02	−·03	*−·67*	·00	−·03	·20	·57
Worry re school	F 37	·03	−·02	−·02	·06	*−·74*	−·05	−·02	−·19	·04	·07	−·15	−·10	·63
Worry	F 61	·02	−·03	·30	·35	·36	*·53*	−·08	·07	·13	−·13	−·04	·06	·67
Anger	F 71	·18	·06	·01	−·13	·01	*·49*	·30	−·32	−·06	−·11	·14	·13	·54
Frightened	F 72	−·00	·01	−·25	·10	−·06	·33	·39	*·46*	−·08	−·15	·30	−·20	·71
University plans	F 73	−·11	−·17	−·14	·08	−·03	−·11	*−·71*	−·13	−·08	·15	·09	−·12	·65
Anxiety	F 75	−·02	−·01	·12	·15	·15	·08	−·11	·03	·04	−·07	*·62*	−·34	·59
Hockey	F 81	·09	·19	·14	·18	·02	·15	·06	−·18	−·11	−·10	·01	*·68*	·46
Ominous	F 82	·01	−·07	·14	·21	·15	*·66*	·05	·24	−·03	−·12	−·08	−·02	·61
Watching TV	F 85	·21	·11	·15	−·06	·13	−·02	·05	·01	·17	−·06	*·65*	·16	·58
Complaining	F 91	·11	·06	−·13	−·10	−·04	*·74*	·00	−·06	−·05	·12	·17	·03	·64
Factory work	F 97	·04	−·07	·23	*·67*	−·08	−·04	−·03	−·16	−·06	·14	·13	·11	·59
Uptight	F 103	·03	·11	−·07	*·60*	−·02	·11	−·10	·14	−·24	−·26	·02	·03	·55
Percentage of Variance:		16·6	7·2	6·0	4·6	4·2	4·0	3·6	3·6	3·4	3·2	3·1	2·9	

Total variance accounted for: 62·4%

ambition and parental behaviour. LI set their academic ambitions lower, and tend to feel that their parents are more punitive.

Factor 8 accounts for 3·6 per cent of the variance and identifies feelings related to worry and isolation. LI tend to participate less in social and cultural activities, and feel frightened more often than the average-, and high-intelligent average-achievers.

Factor 9 accounts for 3·4 per cent of the variance and identifies attitudes related to efficiency and initiative. LI tend to be less efficient in finishing their homework, take less initiative for volunteering in class, but at times do say things they should not.

Factor 10 accounts for 3·2 per cent of the variance and identifies attitudes related to meeting the demands made by the school. LI feel to a much lesser extent that school rules and regulations are reasonable, have more detentions, and are less conscientious about finishing their homework properly.

Factor 11 accounts for 3·1 per cent of the variance and identifies attitudes related to anxiety. LI find it more difficult to concentrate on a test, are more squeamish about the idea of getting an injection, and prefer to watch TV to reading.

Factor 12 accounts for 2·9 per cent of the variance and identifies preferred play activity. LI tend to like hockey more than the average-, and high-intelligent average-achievers.

It is entirely obvious that the average-achieving males do not constitute a homogeneous group, but can be meaningfully subdivided into low-, average-, and high-intelligent groups which are significantly different from each other on the attitudinal correlates of academic achievement. It appears that the low-intelligent average-achievers (1) have a lesser sense of accomplishment, (2) have a greater sense of helplessness and failure, (3) have less drive and satisfaction, (4) have different and more accepting attitudes toward manual labour, (5) are less positive about the school, (6) are less stable in terms of mental health, (7) are less ambitious, and positive toward their parents, (8) experience more feelings of worry and isolation, (9) are less efficient and take less initiative, (10) experience the demands of the school as too heavy, (11) are more anxious, and (12) are more sports-oriented.

Female Sample

Based on the regression equation method, 58 subjects were classified as under-achievers, 140 as average-achievers, and 65 as over-achievers (Table 1). The three achievement groups did not differ significantly in average age or intelligence, but were again significantly different from each other in average achievement test scores.

Item analysis revealed that 11 items discriminated significantly and systematically between the under-achieving, average-achieving, and over-achieving groups (Table 5). Factor analysis indicated four factors which account for 56·3 per cent of the variance.

Factor 1 accounts for 22·7 per cent of the variance and identifies self-evaluation related to social and artistic matters. Under-achievers perceive themselves as less talented in music, less involved in what goes on in school, and as picking more on brother(s)/sister(s).

Factor 2 accounts for 12·6 per cent of the variance and identifies feelings related to accomplishment and popularity. Under-achievers tend to volunteer less often when the teacher asks a question in class, their homework is often not finished properly, they are not as popular in being chosen for games, and seem to be less successful when trying to make something. On the other hand they feel that they get into less trouble than the average-, and over-achieving girls.

Factor 3 accounts for 11·4 per cent of the variance and identifies attitudes toward work and entertainment. Under-achievers tend to feel more often that everything

TABLE 5

ROTATED FACTOR MATRIX OF THE DISCRIMINATING ITEMS FOR THE UNDER-, AVERAGE-, AND OVER-ACHIEVING FEMALES

		Factors				
Items	Item No.	1	2	3	4	h^2
Homework finished	S 34	−·27	−*·60*	·11	−·00	·44
Volunteering	S 39	−·12	−*·65*	−·14	−02	·46
Good in music	P 24	*·82*	·01	·00	·04	·67
Dreamer	P 31	*·78*	·02	·16	·07	·64
Pick on others	P 32	*·69*	·20	·01	−·20	·56
In trouble	P 34	−·18	*·54*	·04	·02	·33
Unpopular	P 46	·23	*·46*	−·03	−*·68*	·73
Unlucky	P 61	·06	*·47*	*·55*	·01	·53
Office work	F 78	·09	·17	−*·72*	·06	·56
Watching TV	F 85	·25	·15	*·66*	−·01	·52
Car mechanic	F 90	·11	·39	−·10	*·77*	·77
Percentage of variance:		22·7	12·6	11·4	9·6	

Total variance accounted for: 56·3%

goes wrong when they try to make something, they feel that they would not like to work in an office upon leaving school, and they would rather watch TV than read.

Factor 4 accounts for 9·6 per cent of the variance and identifies feelings related to social rejection. Under-achievers feel more often that they are the last ones to be chosen for games, and they are somewhat less negative toward the idea of being a car mechanic upon leaving school.

If we wish to summarise the attitudinal characteristics of the female grade six under-achievers, we have to say that (1) their self-evaluation is lower, in terms of social relations, (2) they are lacking in a sense of accomplishment, (3) they have an anticipation of failure, and (4) they manifest feelings of social rejection.

If we wish to compare the attitudinal correlates of under-achievement in girls and in boys, one major difference seems obvious. While the male under-achievers at the grade six level do not seem to feel socially rejected and isolated, the girls do appear to suffer many frustrations in the sphere of social relations. In other words, under-achievement, from a social interaction point of view, appears to have a much more negative connotation for the girls as compared with the boys.

Subdividing the average-achieving females into three groups of different intelligence levels resulted in 45 low-intelligent average-achievers (LI), 49 average-intelligent average-achievers (AI), and 46 high-intelligent average-achievers (HI). The three groups did not differ significantly in age, but were significantly different from each other in intelligence and in level of academic achievement (Table 3). Item analysis of their responses to the three attitude tests (S, P, and F) revealed 20 items which discriminated significantly between the LI, AI, and HI groups (Table 6). Factor analysis indicated five factors which account for 55·8 per cent of the variance.

Factor 1 accounts for 25·8 per cent of the variance and identifies symptoms related to anxiety. LI worry more before a test, feel uptight frequently, and often experience physiological signs of anxiety such as tension, increased heart rate, and trembling.

Factor 2 accounts for 10·0 per cent of the variance and identifies feelings related to self-evaluation. LI see themselves as less smart, and are afraid that others may think they are stupid, they have a less positive anticipation regarding the future, are generally more apprehensive, and tend to give up more easily.

TABLE 6

ROTATED FACTOR MATRIX OF THE DISCRIMINATING ITEMS FOR THE AVERAGE-ACHIEVING LOW-, AVERAGE-, AND HIGH-INTELLIGENT FEMALES

		Factors					
Items	Item No.	1	2	3	4	5	h^2
Homework finished	S 34	−·18	−·23	−*·66*	·24	−·22	·63
Closeness to mother	S 55	·03	−·07	−*·73*	·02	·23	·59
Intelligent	P 5	·01	*·69*	·15	·10	·15	·53
Good ideas	P 16	·17	·36	*·43*	·21	−·32	·49
Decisive	P 18	·15	·30	*·42*	·36	−·11	·43
Giving up	P 20	·16	*·62*	*·48*	·05	·22	·69
Nervous	P 28	·21	·22	·00	*·63*	−·07	·49
Left-out	P 40	·09	−·06	·06	*·79*	·02	·64
Unhappy	P 50	·27	−·09	*·62*	·13	·19	·52
Clumsy	P 64	·09	·18	*·50*	·34	·24	·46
Test anxiety	F 11	*·71*	·21	·20	·16	·14	·63
Self-confidence	F 18	−·11	*·55*	·06	·35	·37	·58
Fast heartbeat	F 21	*·77*	·05	·03	·10	−·04	·61
Like orchestra	F 22	·26	−·12	·11	−·13	·47	·33
Pessimism	F 31	·26	*·64*	·10	·16	−·15	·54
Hand trembles	F 32	*·80*	·13	·04	·04	·12	·67
Like knitting	F 38	·06	·14	−·01	·05	*·71*	·53
Worry	F 43	*·83*	·03	·12	·04	·15	·73
Ominous	F 82	·30	*·67*	−·03	−·18	−·14	·59
Tightened up	F 103	*·56*	·23	·23	·16	−·04	·45
Percentage of variance:		25·8	10·0	7·2	6·5	6·3	

Total variance accounted for: 55·8%

Factor 3 accounts for 7·2 per cent of the variance and identifies feelings related to accomplishment. LI tend to perceive themselves as less decisive and persistent, they feel that they are clumsier, and their homework is often not finished properly. They feel that they have fewer good ideas, are less happy, and have less contact with their mothers about everyday problems.

Factor 4 accounts for 6·5 per cent of the variance and identifies attitudes toward social relations. LI perceive themselves as more nervous but they feel that they are left out of things to a lesser extent than the average-, and high-intelligent average-achievers.

Factor 5 accounts for 6·3 per cent of the variance and identifies preferred cultural and leisure activities. LI are more fond of orchestral music and knitting than the average-, and high-intelligent average-achievers.

Just as was the case with the average-achieving males, the average-achieving females do not constitute a homogeneous group either, but can be divided into low-, average-, and high-intelligent subgroups which are significantly different from each other on the attitudinal correlates of academic achievement. The low-intelligent average-achievers differ from the average-, and high-intelligent average-achievers in the fact that they (1) experience more anxiety, (2) tend to have a more negative self-evaluation, (3) experience more feelings of lack of accomplishment, (4) perceive their social relationships as better, and (5) have different preferences for their cultural and leisure activities.

It is now sufficiently clear that the average-achievers do not constitute a homogeneous group with regard to attitudes relevant to academic achievement, but can be meaningfully subdivided along the dimension of intelligence into subgroups which are significantly different from each other in terms of attitudes related to academic achievement. This fact, of course, has important implications for a more sophisticated analysis of the attitudinal correlates of academic achievement. The conclusion appears justified that the attitudinal correlates of academic achievement vary not only as a function of level of academic achievement, but as a combined function of level of academic achievement and intelligence.

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EXAMINATION PAPER LENGTH: HOW MANY QUESTIONS?

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SUMMARY. The effect of examination length on inter-marker reliability has been investigated for four three-hour examinations in engineering subjects. The shortening of the examinations has been simulated by considering alternative combinations of solutions from scripts from the full-length examinations which have already been subjected to multiple marking. The results suggest that the five or six solutions required in the full-length examinations are too few to assess the candidates accurately. As expected, reducing the length of the examination increases the effect of marking error.

INTRODUCTION

THE duration of examinations seems to be fixed by custom, commonly three hours long they are occasionally shorter and exceptionally longer. The number of questions set and required of the candidates are each roughly correlated with the length of the course as measured by hours of lecturing, which can be taken as a rough measure of the amount of material covered in the course. Data from the three years of the B.Sc. (Engineering) examinations in the author's department are shown in Figure 1. For the examinations featured in Figure 1 the questions in any one paper are notionally of the same duration, typically they are of the ' problem ' type. Omitted from the figure are four examination papers which each contain a mixture of questions of different durations, e.g. problem questions plus multiple-choice questions.

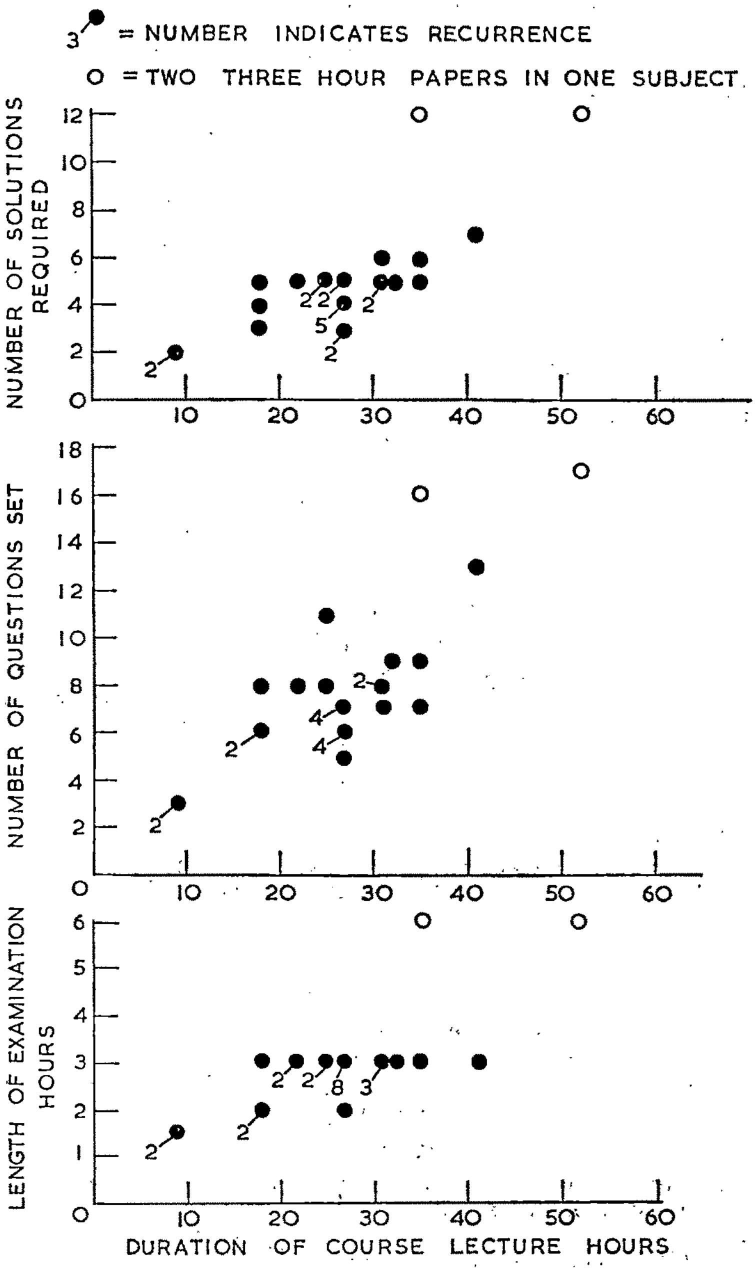
If the content and duration of the course, the question type and notional duration of the questions are all held constant, what would be the effect of changing the number of solutions required from the candidates? It is desirable that an examination should test the knowledge and skills taught in the course, omitting nothing significant nor including anything extraneous; the examination is then said to have high content validity. If the number of questions is too low (low content validity), then some of the candidates who are not uniformly well prepared across the whole of the syllabus will perform relatively less well than others in the same group because the available questions correspond badly to their areas of good preparation; the results of such an examination will exaggerate the differences between candidates. Up to the point at which additional questions begin to cover the same ground as previous questions, the content validity of the examination will increase as the paper contains more questions so that the random element in the results is diminished and the fairness to candidates thereby increased.

Examination marks are not perfectly reliable, that is to say that if the assessment is repeated in some way the candidates will generally receive a second mark which is different from the first. The unreliability of examination marks is attested by many studies (for example, Cox, 1976) which together have covered a wide range of subjects at school and university levels. Thus a candidate's single mark from an examination should be thought of as subject to some uncertainty, which, in the absence of further information about the particular examination, can be estimated only from empirical studies of similar examinations.

The two sources of unreliability which are relevant to the present discussion are inter-marker differences whereby different markers assign different marks to the same script, and inter-examination (or inter-question) differences whereby examination questions of uneven difficulty are set although the intention is to make them of equal

FIGURE 1

VARIATION OF EXAMINATION LENGTH WITH DURATION OF COURSE



difficulty. The effect of increasing the number of solutions required of candidates is expected to be generally to increase the reliability of the total mark. Qualitatively, this increase of reliability is expected because the greater the number of components in the assessment the more likely are the random errors in the marks for different components to cancel one another, thereby diminishing their total effect. This is illustrated by Bull's (1956) work on the marking reliability of three-hour examinations in which the candidates were required to attempt 4, 8, 16 and 32 questions. As the number of questions rose from 4 to 8 and 16 there were appreciable increases in the values of the coefficients of correlation between the different marks from a single marker and between the marks from different markers. In this case the increase in reliability is attributable not only to the increased number of questions but perhaps also to qualitative changes in the nature of the questions as they were shortened to fit the constant duration of the examination. The shorter is the solution time the more specific must be the question and so the candidates and markers alike are more likely to follow the expected solution.

In many examinations, including the university degree examinations considered here, an important feature is to discriminate between candidates according to their marks. What credence can be given to the apparent differences between candidates as evidenced by their different positions in the marks list? One aspect is to distinguish between candidates of markedly different capability, i.e. how well are the least able distinguished from the most able. A further aspect is to distinguish between candidates of near-equal ability, e.g. in adjacent positions in the marks list. The discriminating power of an examination depends upon the number of questions in the examination because this influences both the mark reliability and the number of possible positions in the marks list. A theoretical estimate of the effect of examination length on reliability and on discrimination is discussed later.

The desirable characteristics of an examination—validity, reliability and discrimination power—may each be expected to increase with an increase in the number of solutions required of the candidates, but simultaneously there will be an increase in the burden upon the candidates and examiners through the sitting, setting and marking. Whether a particular examination should be shorter or longer is an important question for the examiner, albeit one which is rarely asked.

Some theoretical guidance on the dependence of reliability upon examination length can be obtained from Spearman's (1910) analysis, at least for the asymptotic condition in which an examination requires a candidate to attempt a large number of questions. The analysis is based on the idea that an examination of which the length is increased n times can be thought of as a sequence of n examinations each of the former length. The notional n examinations must be fully equivalent to one another and to the original examination so that they test the same abilities in the candidates and have the same level of difficulty with equal variances and co-variances of their marks. If the maximum allowable mark is proportional to n the true and error variances of the marks, σ_{cn}^2 and σ_{en}^2 respectively, of the examination of length n are related to the true and error variances, σ_c^2 and σ_e^2 of the former examination:

$$\sigma_{cn}^2 = n^2\sigma_c^2 \tag{1}$$

$$\sigma_{en}^2 = n\sigma_e^2 \tag{2}$$

The reliability of an examination is measured by the ratio of the true variance to the sum of the true and error variances:

$$\text{Coefficient of reliability} = \frac{\text{true variance}}{\text{true variance} + \text{error variance}}$$

$$r = \frac{\sigma_c^2}{\sigma_c^2 + \sigma_e^2} \tag{3}$$

Equations (1) and (2) show that the true variance increases more rapidly with n than does the error variance and so the coefficient of reliability increases as n increases.

The variation of reliability with examination length is expressed by the Spearman-Brown formula:

$$r_n = \frac{nr}{1+(n-1)r} \tag{4}$$

where r_n and r are the reliabilities of the examination of length n and unity respectively.

The discriminating powers of an examination are measured by suitably defined discrimination coefficients. Discrimination between candidates of near-equal ability is measured by a local discrimination coefficient d_1 defined in terms of the minimum increment in the marks distribution $\Delta\chi$ and the error variance, or more conveniently the standard deviation of the error (square root of the error variance) σ_e

$$d_1 \equiv \frac{\Delta\chi}{\sigma_e} \tag{5}$$

The greater is the value of d_1 the more reliably does the examination discriminate between candidates of near-equal ability. For the equivalent examinations considered above the local discrimination coefficient will depend upon the examination length because the error variance depends upon this, although $\Delta\chi$ does not.

$$\begin{aligned} d_{1n} &= \frac{\Delta\chi_n}{\sigma_{en}} = \frac{\Delta\chi}{\sqrt{n}\sigma_e} \\ &= \frac{d_1}{\sqrt{n}} \end{aligned} \tag{6}$$

Thus the value of the local discrimination coefficient is inversely proportional to the square root of the examination length n.

In a similar fashion an overall discrimination coefficient d_o which is a measure of power of the examination to distinguish between candidates of markedly different ability can be defined as the ratio of the square roots of the true and error variances

$$d_o \equiv \frac{\sigma_c}{\sigma_e} \tag{7}$$

The greater is d_o the better does the examination discriminate. The coefficient of overall discrimination is closely related to the coefficient of reliability

$$d_o = \sqrt{\frac{r}{1-r}} \tag{8}$$

and for equivalent examinations

$$d_{on} = \sqrt{\frac{r_n}{1-r_n}} = \sqrt{\frac{nr}{1-r}} = \sqrt{n}\, d_o \tag{9}$$

Thus the overall discrimination improves with increase of examination length, the value of the overall coefficient being proportional to the square root of the examination length n.

In Spearman's analysis the maximum allowable mark is proportional to the length of the examination. It will be convenient to consider the alternative formulation in which the maximum allowable mark is held fixed; the effect of increasing the examination length is then to decrease the step-size in the marks distribution. Equations (1) and (2) are rewritten in terms of the corresponding variances;

$$\tilde{\sigma}_{cn}^2 = \tilde{\sigma}_c^2 \tag{10}$$

$$\tilde{\sigma}_{en}^2 = \frac{\tilde{\sigma}_e^2}{n} \tag{11}$$

$$\Delta\tilde{x}_n = \frac{\Delta\tilde{x}}{n} \tag{12}$$

The definitions of the coefficients of reliability and discrimination (3), (5) and (7) are unchanged as are equations (4), (6) and (9) which show the dependence of these coefficients upon examination length for the equivalent examinations considered by Spearman.

The conclusions about the influence of examination length which are drawn from equations (1), (2), or (10), (11), and (4) (6) and (9) are each contingent upon the assumed equivalence of the examinations. This may be a reasonable assumption in the case of objectively marked examinations, e.g. ones composed of multiple-choice questions, where the short answering time for each question means that the numbers of questions can be high enough for each of the notional n examinations to contain a sufficient number of questions to sample adequately the width of the syllabus and the range of abilities which are to be assessed. For conventional university-level engineering examinations, which are considered in the present study, the candidates are required to attempt only a small number of questions; under these conditions it is doubtful that the assumptions behind the Spearman-Brown formula will be valid. Nevertheless, equation (4) has been used by McVey (1975) to predict the effect of doubling the length of such an examination although the prediction was not tested by observation. The purpose of the present study is to investigate empirically, for a sample of university examinations in engineering, the influence of examination length on reliability and discrimination.

PRESENT STUDY

For the sort of examination considered here it is not practical to hold several such examinations of different length in a particular subject with the same candidates and markers, not least because examinations are not popular with examiners, markers or candidates alike. Accordingly, the present study simulates the effect of shortening the length of an examination by considering alternative combinations of solutions from scripts from genuine full-length examinations which have already been subject to multiple marking, and so the reliability of the notional, shorter, examinations can be found from an analysis of variance. The data for the full-length examinations are taken from previous investigations (Hill, 1975, 1977) of first year and second year university examinations in engineering subjects.

In each of the three examinations in Fluid Mechanics, Thermodynamics and Structures, the scripts selected for study here were from the nine or ten candidates who had each attempted the same full set of five or six questions, as required for the paper. Thus, for example, from an examination in which six solutions were presented there are 20 different combinations of three solutions only. In all, the scripts from this original examination produce 62 notional examinations of length one to five solutions inclusive, all of which have been analysed. The size and composition of the group of candidates was the same for the full-length examination and all the notional examinations derived from it.

Apart from one difference the same procedure was adopted to construct notional examinations from the Strength of Materials examination considered in the previous study (Hill, 1977). The difference arose because in that study the sample of 15 candidates was selected in advance of the examination and in the event they attempted a variety of combinations of questions. Consequently, the composition and size of the group of candidates attempting each notional Strength of Materials examination varied from one to another. Only those examinations which were attempted by five or more candidates were considered in the analysis.

The multiple marks for each of the notional examinations were analysed for variance following the procedure described by Maxwell and Pilliner (1968) and outlined in Table 1.

TABLE 1

Source of variation	Degrees of freedom	Sums of squares	Expected mean square
Markers	$m-1$	$c(\underset{m}{\acute{E}\Sigma_j} - \bar{T})^2$	$\sigma_o^2 + c\sigma_m^2$
Candidates	$c-1$	$m\sum_{c}(\bar{C}_i - \bar{T})^2$	$\sigma_o^2 + m\sigma_c^2$
Residual	$(m-1)(c-1)$	by difference	σ_o^2
Total	$mc-1$	$\sum_{m}\sum_{c}(X_{ij} - \bar{T})^2$	

where m is the number of markers
c is the number of candidates
X_{ij} is the mark awarded to the ith candidates by the jth marker
$\bar{E}_j$ is the mean mark awarded by the jth marker over all candidates
$\bar{C}_i$ is the mean mark received by the ith candidate over all markers
$\bar{T}$ is the mean mark over all candidates and markers
σ_c^2 is the variance of the candidates' mean marks (the true variance)
σ_m^2 is the variance of the markers' mean scores
σ_o^2 is the residual variance

Because the inter-examination error is of interest here, the error variance is defined as the sum of the residual variance and that attributable to the markers

$$\sigma_e^2 \equiv \sigma_o^2 + \sigma_m^2 \qquad (13)$$

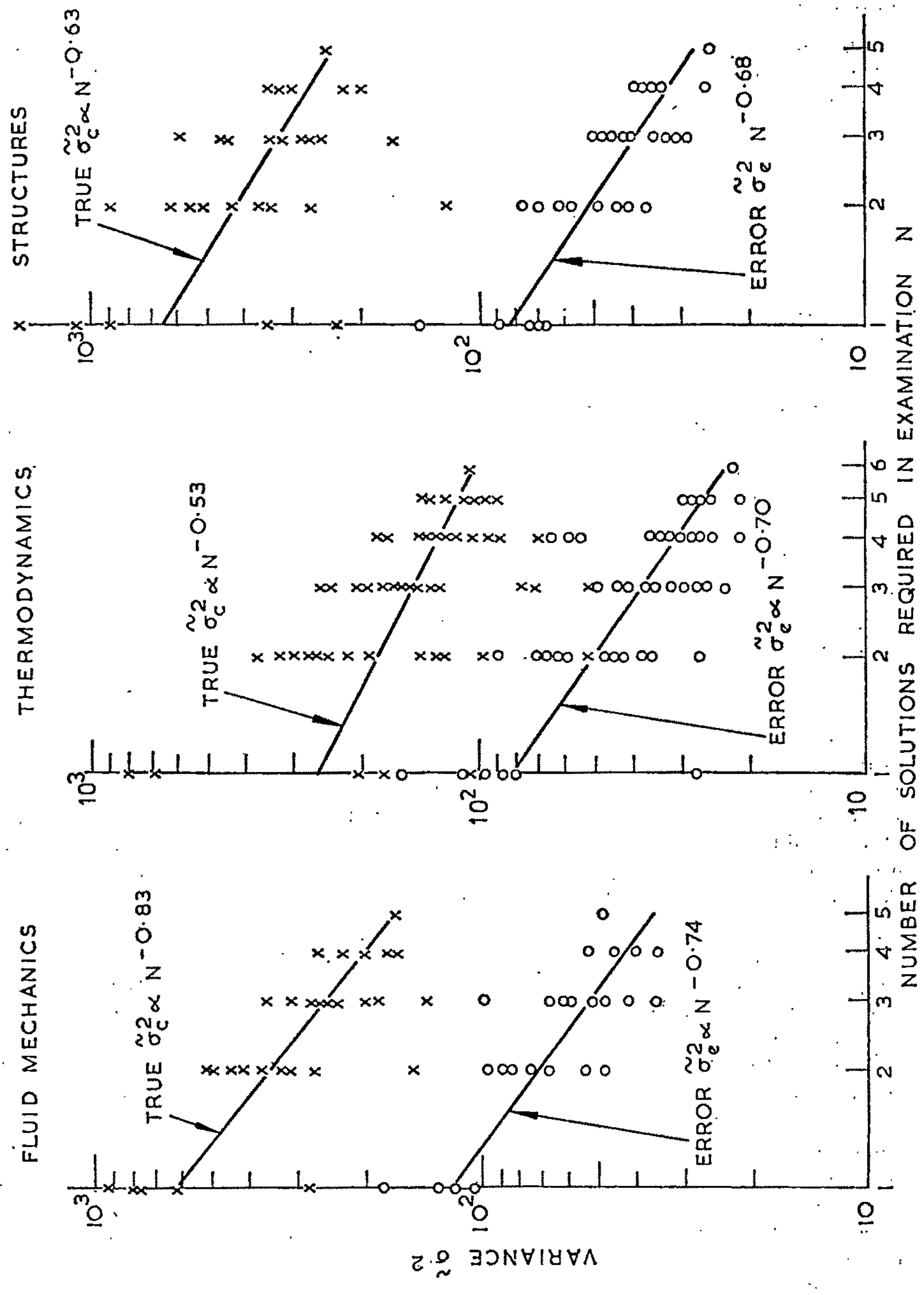
For ease of comparison with the common situation in which the maximum allowable mark in an examination is 100, the results have been presented in that form. Thus, for example, when a single question originally marked out of a maximum of 20 is here considered on its own as a notional examination, the maximum mark is 100 and the possible steps in the marks distribution are 0, 5, 10 . . . In the same way, five such questions considered together as a notional examination still have a maximum mark of 100 but the steps in the marks distribution are now 0, 1, 2, 3 . . .

RESULTS AND DISCUSSION

Figure 2 shows for each of the three examinations from the first study (Hill, 1975) the effect of shortening the examination on the calculated true and error variances. The broad pattern is the same for all examinations: for any particular length of notional examination there is a wide range of values of the true and error variances; the range and mean values of the variances increase with decreasing examination length; the actual values of each variance are similar for each examination subject.

Because all the notional examinations in a given subject share a common group of candidates the apparent increase in true variance with a decrease in examination length must be a spurious effect which is attributable to the short examinations being non-homogeneous through uneven difficulty and low content validity. Clearly, equation (10) is not satisfied. There is no evidence from any of the three subjects that the true variance has reached an asymptotic value at any length of examination less than the full-length and so it must be conjectured whether even the full-length examinations provide an adequate sampling of the syllabus. A crude measure of the quantity of the

FIGURE 2

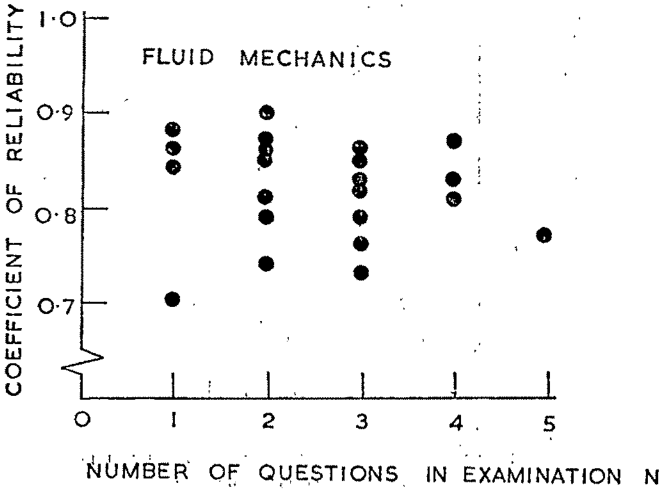

FLUID MECHANICS
THERMODYNAMICS
STRUCTURES
TRUE $\tilde{\sigma}_c^2 \propto N^{-0 \cdot 83}$
ERROR $\tilde{\sigma}_e^2 \propto N^{-0 \cdot 74}$
TRUE $\tilde{\sigma}_c^2 \propto N^{-0 \cdot 53}$
ERROR $\tilde{\sigma}_e^2 \propto N^{-0 \cdot 70}$
TRUE $\tilde{\sigma}_c^2 \propto N^{-0 \cdot 63}$
ERROR $\tilde{\sigma}_e^2$ $N^{-0 \cdot 68}$
10^3
10^2
10
1
2
3
4
5
6
VARIANCE $\tilde{\sigma}^2$
NUMBER OF SOLUTIONS REQUIRED IN EXAMINATION N

material open to examination in each of the subjects is given by the number of lecture hours in the courses: Fluid Mechanics 22, Thermodynamics 22, Structures 34.

Notwithstanding the wide range of values of the error variance for a notional examination of a particular length, the general decrease of error variance with an increase of examination length, which is attributable to the mutual cancellation of errors, is broadly in line with equation (11). Theoretically the error variance is proportional to $N^{-0\cdot5}$; from the mean curves of Figure 2, the observed proportionality is $N^{-0\cdot7}$. The predicted decrease of the coefficient of local discrimination with increase of examination length is confirmed: the local discrimination coefficient is observed to vary as $N^{-0\cdot65}$ whereas theoretically it varies as $N^{-0\cdot5}$.

FIGURE 3

DEPENDENCE OF RELIABILITY UPON EXAMINATION LENGTH

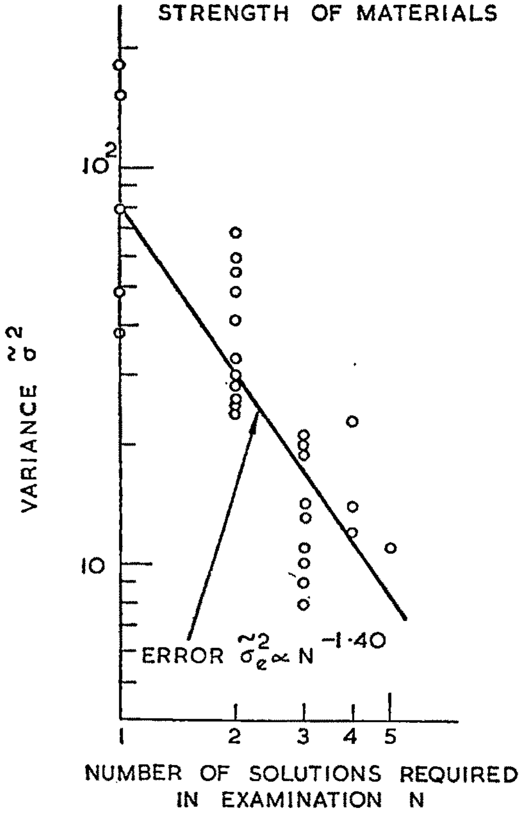


The results for each subject show apparently that the value of the coefficient of reliability is independent of the length of the examination; Figure 3 illustrates this for the Fluid Mechanics examination. As the coefficient of reliability appears to be independent of examination length then, by equation (8), so is the coefficient of overall discrimination. In each case this apparent independence is thought to be false because it is caused by the spurious dependence of true variance upon examination length which is referred to above.

The results of the second year Strength of Materials examination from the second earlier study (Hill, 1977) are illustrated in Figure 4. Because of the lack of commonality amongst the candidates taking the different notional examinations in Strength of Materials, the calculated true variances cannot be meaningfully compared with one another and so they are not shown in Figure 4. A similar picture to that of Figure 2 emerges: there is a wide scatter of error variance but an overall reduction with an increase of examination length, this dependence being appreciably stronger than was observed in the other examinations.

The present study has not established what is the lowest tolerable number of required solutions, or indeed whether these full-length examinations were satisfactory in this respect. Further studies will be needed to establish this limit; possible methods of increasing the number of questions in the full-length examination are (i) to increase the duration of examinations beyond three hours and/or up to three hours for

FIGURE 4



examinations which are already shorter, (ii) to shorten the required solutions somewhat without at the same time altering the general nature of the questions.

Commonly, as in the examinations considered here, all or a large proportion of the questions in engineering examinations are of the problem type, the successful solution of which requires both the necessary factual knowledge and appropriate problem-solving skills, neither of which is alone sufficient to achieve a solution. Thus in an examination in which the questions cover too narrow a part of the syllabus a candidate who is not well prepared across all the syllabus may be prevented from displaying his talents adequately. Arising from the present study, a potentially valuable innovation in routine examinations would be to use a two-part paper which assessed factual knowledge and problem-solving skills separately. Factual knowledge across the whole syllabus would be assessed by a large number of short-answer questions, perhaps objectively marked. The problem-solving skills would be tested by problem questions designed to minimise the amount of factual knowledge which the candidate must have in order to achieve a solution.

CONCLUSIONS

For the engineering examinations studied here:

(1) The apparent change of true variance with a reduction of examination length

suggests that even for the full-length examination the number of solutions required is too low for the candidates to be assessed accurately.

(2) Although there is a wide scatter in the values of error variance for any given length of examination, there is overall a reduction of error variance as the examination length is increased whilst the maximum mark is held constant.

(3) The power of the examinations to discriminate between candidates with near equal marks decreases as the number of required solutions increases. In contrast, the power to discriminate between candidates of markedly different ability increases as the number of required solutions increases.

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RELIABILITY OF MARKING IN EIGHT GCE EXAMINATIONS

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SUMMARY. Eight recent GCE examinations, containing mainly free-response questions, were investigated in terms of their marking reliability. The scripts of 200 randomly selected candidates from each subject were re-marked by a senior GCE examiner, and these marks were compared with the marks awarded previously as a result of team marking procedures. These comparisons revealed differences between the reliability of marking of examinations in different subject areas and also between different papers within individual examinations. These results are discussed in terms of differences between examinations in different subject areas, the effect of increasing the number of questions in an examination, and the effect of including questions other than free-response questions. All of these factors appear to have an effect on the reliability of the marking of these examinations. The results are also compared with other estimates for similar examinations.

INTRODUCTION

THE problems involved in obtaining reliable marks from written examinations have often been stated (e.g. Hartog and Rhodes, 1935; Cox, 1967). Clearly a crucial aspect of this reliability is the degree of divergence between the marks that different examiners would award to the same scripts. For this reason public examining bodies who have to employ large teams of examiners to mark their examinations use various procedures to standardise the marking of these examiners. Chief Examiners and Senior Assistant Examiners are appointed and their job is to supervise the marking of teams of Assistant Examiners. This is done through marking schemes, the sampling of scripts, standardisation meetings and finally through adjustments made to the marks of individual examiners. As the existence and details of these procedures may not be generally known, a brief description of them will be given.

Assistant Examiners are provided with detailed marking schemes, by their Chief Examiner, outlining the way in which they are expected to mark individual questions. They also attend standardisation meetings where the interpretation of this marking scheme is explained to them by their Chief Examiner with reference to the actual scripts which they are going to mark. As a check on whether the Assistant Examiners are complying with the standards set down by the Chief Examiner in the marking scheme, they are required also to send in sample batches of scripts during the marking period. These are scripts, which they have already marked, but their marking is then checked by the Chief Examiner or one of the Senior Assistant Examiners, and they are then returned to the Assistant Examiner with comments.

If, at the end of the marking period, it is still considered that particular examiners have consistently marked either too strictly or too leniently, then the Chief Examiner may decide to adjust all of the marks of these examiners accordingly. This is the final method by which the Chief Examiner attempts to bring into line the marking of his team of examiners, and if these procedures are successful then the final set of marks awarded will reflect the marks which the Chief Examiner would have awarded to the scripts if he had marked them all himself.

This piece of research is, in effect, a test of the success of these procedures in certain General Certificate of Education (GCE) examinations. It is based on the procedure of getting a sample of GCE scripts re-marked by either Chief Examiners or Senior Assistant Examiners in each of a variety of different subjects, so that these marks could be compared with the marks awarded previously as a result of the procedures of team marking already outlined. Because of the intricate procedures of team marking adopted by public examining bodies, it is difficult to relate this research to most other re-marking studies that have been done. Normally, studies have compared the marks given to individual essays by a team of examiners working quite independently of each other (e.g. Finlayson, 1951; Wiseman, 1949; and Vernon and Millican, 1954). Examiners in these studies are usually in no sense working as a team, and the marking of individual essays in this context may be thought to have little relevance for the marking of live examination scripts.

There are, however, two studies in particular which come somewhat closer to the situation which we are investigating. Both of these studies investigated the reliability of marking of GCE scripts and used experienced GCE examiners to do the marking. Akeju (1972) had photocopies of the same 100 West African Examinations Council GCE English Composition scripts marked by ten different examiners and obtained correlations between examiners varying from 0·51 to 0·76. Wood and Quinn (1976) did a similar study in which ten University of London O-Level English Language examiners marked photocopies of the same 100 scripts, and this study produced between-examiner correlations of between 0·40 and 0·70.

This study, apart from giving an opportunity to compare our own between-examiner correlations with those previously reported, also affords the opportunity to compare marking reliability in a variety of subjects, and between different forms of examinations (these vary both in terms of the number of questions to be attempted, and in terms of the number of papers set).

The school subjects chosen for inclusion in the investigation were selected on the basis of being subjects which were mainly examined through the writing of free-response essay type questions. These are generally regarded as being the most difficult type of examination questions to mark reliably. Details of the exact nature of each examination are provided in the next section.

DETAILS OF THE EIGHT GCE EXAMINATIONS INVESTIGATED

(1) An O-level Sociology examination, consisting of one paper. Candidates had been required to answer five out of 12 free-response questions in 2 hours 45 minutes.

(2) An O-level English Literature examination, consisting of one paper. Candidates had been required to answer five out of 15 free-response questions in 2 hours 30 minutes.

(3) An O-level English Language examination, consisting of two papers. In Paper One candidates had been required to answer two compulsory free-response questions in 1 hour 30 minutes, and in Paper Two two compulsory questions (a précis and a comprehension) and two out of four short-answer questions in 1 hour 30 minutes.

(4) An O-level Geography examination, consisting of two papers. In Paper One candidates had been required to answer one compulsory structured question and three out of 11 free-response questions in 2 hours 15 minutes, and in Paper Two four out of 41 free-response questions in 2 hours 15 minutes.

(5) An A-level Government and Politics examination, consisting of two papers. In Paper One candidates had been required to answer five out of 10 free-response questions in 3 hours and in Paper Two four out of 10 free-response questions in 3 hours.

(6) An A-level History examination, consisting of two papers. In Paper One candidates had been required to answer four out of 70 free-response questions in 3 hours and the second paper was chosen from a number of different options,

which required three to be answered from between eight to 72 free-response questions in 3 hours.

(7) An A-level Sociology examination, consisting of two papers. In Paper One candidates had been required to answer four out of 15 free-response questions in 3 hours, and in Paper Two four out of 19 free-response questions in 3 hours.

(8) An A-level English examination, consisting of three papers. In Paper One candidates had been required to answer two compulsory questions (a free-response question and a précis) in 2 hours 30 minutes, and in Paper Two one compulsory comprehension question and three out of 11 free-response questions in 3 hours, and in Paper Three four out of 14 free-response questions in 3 hours.

METHOD

The scripts of 1,600 candidates were selected by taking 200 at random from each of eight different recently sat GCE examinations. This was done after the completion of the normal summer marking period, and all previous marks and comments were removed from these scripts. They were then distributed amongst certain Chief Examiners and Senior Assistant Examiners who had all been involved in the normal summer marking of these scripts. These examiners were instructed to mark their scripts as though they were seeing them for the first time, keeping to the marking scheme and standards as agreed for the marking of the June examinations. The marks awarded on this occasion were then compared with the marks awarded previously.

RESULTS

Table 1 gives Pearson's Product Moment Correlation Coefficient for the two sets of marks given to the sample of scripts selected from each subject.

TABLE 1

MARK/RE-MARK CORRELATIONS FOR INDIVIDUAL PAPERS AND COMBINED PAPER TOTALS

Examination		Paper One	Paper Two	Paper Three	Combined Paper Totals
Sociology	O-Level	0·95	—	—	0·95
English Literature	O-Level	0·80	—	—	0·80
English Language	O-Level	0·75	0·91	—	0·90
Geography	O-Level	0·98	0·97	—	0·98
Government and Politics	A-Level	0·85	0·85	—	0·91
History	A-Level	0·90	0·86	—	0·91
Sociology	A-Level	0·90	0·83	—	0·92
English	A-Level	0·73	0·85	0·76	0·91

These correlations are largely a measure of the agreement in the rank order of candidates produced by the two sets of marks awarded to the scripts. Because it is possible to obtain a high correlation from two quite different sets of marks, it is necessary also to look at the overall distributions of marks awarded on each occasion. These are shown in Table 2.

As the distribution of marks awarded on the two occasions are in every case fairly similar, there is justification for interpreting the correlations between the two sets of marks as a measure of the reliability of those marks. What is interesting to note from Table 1 is the extent to which these correlations vary, both between different papers and between the different subjects.

TABLE 2

MEANS AND STANDARD DEVIATIONS OF THE TWO DISTRIBUTIONS OF MARKS AWARDED TO EACH SET OF SCRIPTS

Examination		Paper	Original Marks		Re-Marks	
			Mean	SD	Mean	SD
Sociology	O-Level	Paper One	43·8	12·7	44·6	11·7
English Literature	O-Level	Paper One	40·2	13·6	40·7	13·2
English Language	O-Level	Paper One	39·8	12·2	38·2	9·8
		Paper Two	37·4	13·6	36·8	13·8
		Total Marks	38·6	11·3	37·5	10·7
Geography	O-Level	Paper One	38·2	13·5	38·9	13·8
		Paper Two	35·0	15·4	34·6	15·1
		Total Marks	36·6	13·3	36·8	13·5
Government and Politics	A-Level	Paper One	38·4	11·3	39·1	10·6
		Paper Two	36·8	10·2	37·3	9·9
		Total Marks	37·6	9·4	38·3	9·4
History	A-Level	Paper One	40·9	14·0	39·3	14·3
		Paper Two	39·0	12·7	39·8	13·2
		Total Marks	39·9	11·9	39·6	12·4
Sociology	A-Level	Paper One	35·4	13·2	36·2	11·5
		Paper Two	37·7	12·7	37·4	10·7
		Total Marks	36·6	11·4	36·9	9·8
English	A-Level	Paper One	46·6	12·0	46·5	8·8
		Paper Two	43·7	11·8	44·1	11·2
		Paper Three	43·3	12·9	42·8	12·9
		Total Marks	44·5	10·1	44·5	9·1

DISCUSSION

It should be made clear that the results of this investigation can only provide evidence about one aspect of the overall reliability of these examinations. This aspect is the reliability of the marking of the examination scripts, and the estimates of this reliability are based on the extent to which marks vary when the same scripts are marked by different examiners. Other aspects of examination reliability which have not been studied here are based on the extent to which the same set of marks would have been obtained if the same examinations had been given to the same candidates on another occasion (' test-retest ' reliability), and on the extent to which the same set of marks would have been obtained if equivalent but different examinations had been given to the same set of candidates (' parallel forms ' reliability).

One of the advantages of limiting examination reliability studies to restricted aspects of that reliability is demonstrated in the results of this investigation by the fact that the reliability of marking seems to depend on a variety of factors. Because of the methodology employed, it is possible to consider each of these factors independently, as well as considering how they may be regarded as combining in their overall influence on the reliability of the marking of these examinations.

The first factor which appears to influence the reliability of marking is the subject area being examined. The mark/re-mark correlations reported in Table 1 suggest that the Geography papers, for instance, lent themselves to more reliable marking than did the English papers. Other similar differences may be noted between the different subject areas covered.

A second factor of importance appears to be the number of marks for individual parts contributing to the final examination marks. This effect of increasing reliability, by having more parts of an examination, is well demonstrated by the case of English A-level. In this example, three individual papers, with comparatively unreliable marks, are combined to give a set of total marks, which are just as reliable as the marks from more reliable but shorter examinations in some of the other subjects. This observation is consistent with the established principle that combinations of unreliable measurements are more reliable than the individual measurements themselves, and confirms the general rule of Ebel (1972), that lengthening the number of parts of examinations and tests usually tends to increase their overall reliability. This principle clearly applies both to the number of papers included in the final assessment as well as to the number of questions included within each paper.

The third factor, which appears to affect the marking reliability of these examinations, is the type of questions included in the different papers. In some cases it is difficult to separate out the effect of this factor, from the effect of having different numbers of questions on different papers. However, within English Language O-level, Geography O-level and English A-level, there is a certain amount of evidence that question type is an important variable; this has been verified further by analysing the results for some of the individual questions within these papers separately. The reasons why more closely defined questions might be more reliably marked than the free-response essay questions are understandable in terms of the nature of the instructions which can be given to examiners in these different situations.

The fact that English Literature O-level, which is a short examination consisting of a small number of free-response questions, produced an overall level of marking reliability which compared unfavourably with the other English examinations included in this investigation, both confirms the influence of these factors and also demonstrates their cumulative effect.

CONCLUSIONS

The fact that in seven out of eight of these GCE examinations the mark/re-mark correlations were higher than 0·90, indicates a favourable comparison with the reported reliability of marking of other similar examinations. There is, however, within the results for these eight different examinations, a considerable amount of information about some of the major factors which cause the reliability of marking to vary from subject to subject and paper to paper. Recent trends have been towards examinations comprising more than one paper and including questions other than those of the free-response type. The findings of this study indicate that such trends are likely to result in examinations which will lend themselves to an enhanced level of marking reliability.

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CHILDREN'S DEVELOPMENT AND USE OF INFERENCES ABOUT INTENTIONS AND MOTIVES IN MORAL JUDGMENT

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SUMMARY. A sample of 42 children, age 5 to 7, were tested for their ability to give appropriate causal accounts of incidents and to consider intentions and motives in judging the characters involved in these incidents. Results indicated that children are able to consider intention before they develop the ability to consider motives in moral judgment. A comparison of the causal accounts and moral judgments showed that children can make the appropriate causal inferences before they are able to make use of these in their moral judgments. This supports an interpretation of immature moral judgments as reflecting a deficiency in mediation rather than a deficiency in capacity.

INTRODUCTION

PIAGET (1932) was by no means the first to observe that younger and older children differ in the manner in which they judge the guilt or innocence of others (Johnson, 1962). Nevertheless, Piaget more than any other has been responsible for stimulating interest in this aspect of moral development. Younger children, he found, based their judgments on the objective consequences, the amount of material damage that a person's actions caused, as much as on the person's intentions. Older children were more likely to consider only the intentions as morally relevant. The study reported here is concerned with two issues raised by Piaget's findings. First, despite the research effort that has been devoted to replications of this work, the nature of the developmental change taking place is still far from clear. Second, the reasons and in particular the necessary cognitive conditions for this change are largely unknown.

It will be helpful at the outset to note a couple of distinctions, both to aid the presentation of this study and to compare its aims with those of related research.

Piaget (1932) emphasised a distinction between what he called the objective responsibility of consequence-based judgment and the subjective responsibility of intention-based judgment. The effect of subsequent research has been to raise these types of moral reasoning to the status of consecutive developmental stages (Hoffman, 1970; Lickona, 1976). There are various reasons to believe this particular stage interpretation is inappropriate. Piaget noted that both kinds of reasoning existed side by side in the judgments of younger children; there was no evidence of an exclusive preference for one over the other. Research by Gutkin (1972) indicates a reason for this; he suggests there are four developmental stages, not two. In the first stage intentions are not considered. In the second, intentions are considered but consequences are seen as more important. In the third, consequences are no longer seen as more important than intentions and in the final stage they are not considered at all. The younger children described by Piaget would be at what correspond to Gutkin's second and third stages. This should also underline the fact that emergence of intention-based judgments is not equivalent to the eclipse of consequence considerations. Indeed, the dichotomy implied by the two-stage view is doubly inappropriate because it is never a matter of either the magnitude of the consequences or the nature of the intentions being important. It is rather a matter of whether or not intentions are seen to modify the moral significance of consequences.

One practical lesson of Gutkin's findings is that if one wishes to study the emergence of intention-based considerations in moral judgment one should take care to avoid confounding this development with the changes in attitudes towards consequences. The procedure used by Piaget and emulated in most subsequent research was to present children with imaginary incidents in which were varied both the intentions of the characters and the amounts of damage caused by their actions. Since interest in this study was confined to the child's ability to consider intentions in moral judgments any systematic variation of consequences was avoided.

The second point concerns the distinction between reasoning and evaluation. The children in Piaget's studies were asked to evaluate the characters in these imaginary incidents—to say whether they were naughty or deserved to be punished—and to give reasons for their evaluations. Piaget was clearly less interested in the evaluations themselves than in the underlying reasoning.

Efforts to study moral judgment with a greater degree of experimental control (e.g. Buchanan and Thompson, 1973) have led almost inevitably to an emphasis on the evaluations rather than the reasoning since it proves easier to control the conditions of the former than those of the latter. One need not insist that a Piagetian perspective cannot be assimilated to the requirements of experimental rigour in order to see that this represents a significant change of emphasis. Evaluation and reasoning are not equivalent and there are no grounds for supposing that they will show similar developmental patterns.

From experiments designed to test the effects of consequences and intentions on evaluation, it can be found that intentions influence the evaluations of children below the ages indicated by Piaget's research while consequences influence evaluations in children much older than one might anticipate from his data (e.g. Weiner and Peter, 1973). All ages seem to be influenced by both intentions *and* consequences though the younger children are more influenced by consequences than the older and the older more by intentions than the younger. But it would be an error to conclude that the same is true of reasoning. It is well documented that children can arrive at the right answers to problems and for the right reasons long before they can adequately articulate the reasons (e.g. Piaget, 1977). They can also arrive at the right answers by chance, for the wrong reasons or for no reason at all.

On the other hand it is of some interest that people's evaluations are still influenced by factors such as the seriousness of damage well beyond the age at which they have ceased to accept the moral relevance of these factors in their consciously articulated reasoning. How and why this happens is an important question, deserving of more consideration than it currently receives, but it is not a question the present study is concerned with. As a general observation, it is probably the case that developmental changes at the level of reasoning are very much more distinct and clear-cut than changes at the level of evaluations.

Subjective responsibility or the consideration of intentions in moral judgment can be taken to mean two quite distinct things. On the one hand it can be defined as the judgment of responsibility for intended as against accidental consequences of action. On the other it could mean consideration of the quality of the motives involved, e.g. whether selfish or selfless. The first will be called the *intention* criterion, the second the *motive* criterion. One might on logical grounds deduce that the ability to apply the motive criterion implies an ability to apply the intention criterion, but not vice versa. Therefore it would be predicted that judgment problems requiring application of the intention criterion will be easier and mastered earlier than those involving the motive criterion. Existing research provides little clarification of this issue. In some cases, as in Piaget's work, the distinction has been confounded while in others either one or the other definition of subjective responsibility has been used. Oddly, there has been only one explicit acknowledgment of this distinction (Berndt and Berndt, 1975) to the knowledge of the author and no systematic attempt to compare application of the criteria. An attempt to do so was one objective of the research reported here.

It was decided to follow Piaget in using pairs of stories to pose the relevant judgment problems rather than single stories. Although single stories are increasingly preferred in moral judgment research (cf. Buchanan and Thompson, 1973; Weiner and Peter, 1973) they are poorly suited to an examination of this particular distinction. Judgments of single incidents may appropriately appeal to the deliberate nature of the act *or* the motives involved. Only pairs of stories in which relevant contrasts are included can distinguish these criteria.

A relevant contrast for the intention criterion is, obviously enough, between incidents in which the damage is accidental and incidents in which it is deliberate. For the motive criterion, however, there are at least two possibilities. The most commonly used format in Piaget's inquiries depicted characters who caused some damage accidentally while engaged in activities either for praiseworthy or for dubious motives. In effect the judgment task indicates whether children choose to judge the actors in terms of the accidental consequences, or in terms of the actions and the intentions involved. It is a task which determines whether a child can, in Piagetian terminology, *decentre* from the perceptually compelling physical dimensions of the consequences to the psychological meaning of the actions. An alternative case would contrast instances of deliberate damage in which the motive was either good or bad. If decentration is involved in these problems then this should be easier than the previous contrast in that it requires less decentration. No directly comparable task was used by Piaget though he employed a similar contrast involving deliberate theft either for good or for bad reasons. Judgments in this case may well be distorted by the additional factor of the negative label attached to this form of behaviour. Both forms of contrast relevant to the motive criterion as well as contrasts relevant to the intention criterion were included in the design of this study.

To the extent that children do fail to base their judgments on appropriate intentions or motives what reasons can be suggested for this failure? Bearison and Isaacs (1975) identify two possibilities. One is that while a child is able to infer intentions or motives appropriately, these inferences do not mediate his moral judgments; i.e. there is a *mediation* deficiency. This is consistent with examples quoted by Piaget (1932) in which children clearly made the right causal inferences but did not use them in their judgments. The other possibility is that the child is simply failing to make the necessary inferences even though it is able to do so; i.e. a *production* deficiency. Bearison and Isaacs' (1975) own findings favour this interpretation but there are at least two other possibilities that should be considered. First, a *capacity* deficiency could be responsible; the child could be incapable of making the correct inference. This view is endorsed by Berndt and Berndt (1975) who additionally suggest that errors of inference arise because children infer intentions and motives from consequences; these children assume that what happens is what is intended and what is negative is ill-intended. The final possibility is that although children are presented with or prompted to make the appropriate inferences—as in the Bearison and Isaacs study—some will still fail to make proper use of them in their moral judgments. In other words it is possible that there will be mediation deficiencies independent of production deficiencies. Bearison and Isaacs' findings do not allow us to eliminate the former hypothesis.

Direct evidence concerning the child's ability to make causal inferences about human behaviour is in short supply, though it seems young children—4 to 6 years old—have difficulty in distinguishing accidental from intentional effects (King, 1971). It has not been established whether there is a similar deficiency in capacity to distinguish selfish and selfless motives in this age range nor whether either is related to inability to make intention- or motive-based moral judgments.

The question was examined here by asking children to give accounts of the events to be judged, to explain why the relevant events occurred and to say whether these things happened by accident or on purpose. There are reasons for supposing that children will not react in the same way to questions about why things happened and questions about whether they were accidental or not. Young children are already well aware that adults do not ask whether something was an accident merely out of polite curiosity. They do so to assign blame and punishment.

The normal story technique presents a difficulty for investigation of inference processes. In verbally recounted incidents the intention and motives of the actors are typically explicitly identified; the everyday language in which events are reported is a language of inference, not of pure description. If the child's ability to make inferences about intentions and motives is to be examined then necessarily incidents cannot be represented in a medium in which these inferences are already accomplished. It is necessary to correspond as closely as possible to a data pattern not yet transformed by any inference process. This could be managed with filmed or videotaped enactments (e.g. Chandler *et al.*, 1973) or more cheaply with a pictorial medium, stories in the form of comic strips, and this was the solution adopted.

Certain incidental, but nevertheless significant, advantages accrue from this method. First, there is a possible advantage over the verbal medium of a greater likelihood of holding the attention of young children. Second, since the stimulus is continually before the child's eyes there is considerably less load on memory than with any of the alternatives, a decided advantage where pairs of stories must be judged. This meets a major objection to the verbal method. It has been claimed that presentation order and recall effects influence production of moral judgments to the extent that previous findings of a developmental order may be artefacts of order of information effects (Austin *et al.*, 1977). One could with equal justice claim that order of information effects are artefacts of the verbal presentation medium. It is difficult to see how developmental changes demonstrated with this pictorial method could be attributed to such effects.

METHOD

Sample

The sample comprised 42 primary school children, 7 boys and 7 girls from each of the first three primary levels. Average ages for the three levels were 5 years 7 months, 6 years 8 months, and 7 years 9 months respectively.

Materials

Four pairs of stories were devised for this study, depicting various combinations of intention and motivation. Two pairs contrasted accidents with intended effects and two contrasted selfishly motivated acts with selflessly motivated acts. The story pairs were organised as follows:

Pair A:	1. Unintended consequences	*vs.*	2. Intended consequences (but no motive indicated)
Pair B:	1. Unintended consequences	*vs.*	2. Intended consequences (with motive indicated)
Pair C:	1. Unintended consequences selflessly motivated act	*vs.*	2. Unintended consequences selfishly motivated act
Pair D:	1. Intended consequences selflessly motivated act	*vs.*	2. Intended consequences selfishly motivated act

In all pairs the consequences were material damage or loss. Each story was presented in the form of a cartoon strip that included a bare minimum of verbal material. The cartoon strips were individually mounted on stiff cardboard.

Procedures and coding of responses

Subjects were interviewed individually and all responses taped. Responses were coded from the transcribed interviews. First, the stories were presented individually and subjects were asked to describe what was going on in the story. They were then questioned specifically on two points: whether the character in the story meant to do what he or she did or whether it was an accident; why the character did it. After completing all the stories in this manner the children were questioned on two further points about each *pair* of stories in turn: which of the two characters in each pair was the naughtiest and why; which deserved to be punished the most and why. Responses to these four points provided scores on four measures as follows: (1) Causal inferences (CI)—whether the events were appropriately explained in terms of the relevant natural or psychological causes; (2) Attributions of responsibility (AR)—whether the consequences were appropriately designated as accidental or deliberate; (3) Justifications for blame (JN)—whether judgments of relative naughtiness appealed to relevant causal or motivational differences (" This one is naughtier because he did it on purpose and that one did not mean to do it "; " This one because he did it for himself and that one did it to help someone else "); (4) Justifications for punishment (JP)—whether justifications of differential treatment appealed to relevant causal or motivational differences. Intercoder reliability exceeded 0·9 for all measures.

RESULTS

Each child was given a total score for correct items on each measure. Analyses of variance were performed on each of these measures, using a 3 (Primary levels) × 2 (Sex) design. There were no effects for sex on any of the measures. Effects for primary level were significant at least to the ·01 level on all measures with F's of 6·00 (CI), 12·76 (AR), 11·18 (JN), and 7·91 (JP) respectively, and df = 2/36.

Turning to analysis of differences between individual items, the story pairs did not provide moral judgment problems of equivalent difficulty. As predicted, story pairs A and B which contrasted deliberate with accidental effects were easier than those which contrasted selfishly with selflessly motivated actions (see Tables 1 and 2). That

TABLE 1

FREQUENCY OF CORRECT MORAL RESPONSES FOR STORY PAIRS AND JUDGMENT TASKS (N = 42)

Story pair:	A	B	C	D
Judgment task:				
JN	33	30	7	18
JP	26	28	7	17

TABLE 2

STATISTICAL COMPARISONS OF MORAL JUDGMENT RESPONSES FOR JUDGMENT TASKS JN AND JP

JN Comparisons	P<*	JP Comparisons	P<*
A>B	NS	A<B	NS
A>C	·001	A>C	·001
A>D	·002	A>D	·10
B>C	·001	B>C	·001
B>D	·002	B>D	·02
D>C	·01	D>C	·02

* McNemar Test for the Significance of Changes.

is, the intention criterion was easier to apply than the motive criterion for the children in this study. This difference was slightly more marked in the case of justifications for judgments of naughtiness than justifications for punishing (see Table 1). As this table also indicates there were differences among the remaining two pairs. Pair D involving deliberate damage proved easier than the pair involving accidental damage, pair C, and this difference was significant for both JN and JP. There was a slight but non-significant tendency for the punishment question to be more difficult than the naughtiness questions but this difference had little effect on the pattern of differences between story pairs.

The two kinds of questioning about causes, CI and AR, were not answered with equivalent facility by all the children. Instead there was a clear tendency for the latter type to pose greater problems. Over eight stories the average number of correct responses on the AR measure was 5·1. Over the same stories the average number of correct responses on the CI measure was 7·4. Thus children in this age range appeared to have very little difficulty in making appropriate inferences about the causes and motives depicted in these stories, although many experienced difficulty in deciding whether effects were accidental or deliberate. Regarding the AR measure there appeared to be two types of erroneous response. Some children would accede to any suggestion made to them, even if the suggestions were contradictory, and seemed to have no idea of the meanings of such terms as ‘ by accident ’ or ‘ on purpose ’. Others would steadfastly assert that an effect was accidental even though they would give a appropriate causal account of the event by making reference to the intention which produced the effect, or in the case of accidents they would insist that the damage was done deliberately. As Table 3 indicates, not all the stories were equally error prone; A2, D2 and particularly D1 seemed the most susceptible.

TABLE 3

FREQUENCY OF APPROPRIATE RESPONSES TO QUESTIONS OF CAUSAL INFERENCE (CI) AND ATTRIBUTION OF RESPONSIBILITY (AR)

Story:	A1	A2	B1	B2	C1	C2	D1	D2
CI	42	35	41	37	37	40	39	40
AR	39	23	32	31	30	31	9	21
P<*	NS	·001	·01	·05	·05	·01	·001	·001

* McNemar Test for the Significance of Changes.

A comparison of the CI data with the moral judgment responses suggests a considerable degree of mediation deficiency. These children can produce the necessary inferences, but many of them still fail to use them in their moral reasoning.

Comparing the moral judgments with the AR data reveals quite a different pattern. The difficulties posed by the judgment taks do not match those posed by the attribution questions. Only for the stories in pair B is the match close. For one of the stories in each of the pairs A and D there were greater difficulties posed by attribution of responsibility than by moral judgment while for pair C the opposite was the case; considerably more children failed the moral judgment task than had problems with attribution of responsibility on either story.

Finally an analysis of the intercorrelations between moral judgment, causal insight, attribution of responsibility and chronological age revealed that all were significantly related (see Table 4). However, with the effects of age partialled out, only the correlations between AR and moral judgment and AR and CI remained significant ($r = \cdot 55$, $df = 39$, $P < \cdot 005$ and $r = \cdot 34$, $df = 39$, $P < \cdot 025$ respectively).

TABLE 4

INTERCORRELATIONS* BETWEEN MORAL JUDGMENT (MJ)†, CAUSAL INFERENCE (CI), ATTRIBUTION OF RESPONSIBILITY (AR), AND CHRONOLOGICAL AGE (CA)

	CI	AR	CA
MJ	·39	·74	·63
CI	—	·55	·50
AR	—	—	·65

* Pearson Product Moment Correlations, N=42; all correlations P<·005.
† Based on combined scores for JN and JP.

DISCUSSION

It is first worthy of note that there was very clear evidence of developmental change in moral reasoning about blame over the somewhat narrow age-band sampled. Although this may be hardly surprising in view of the numerous replications of this result, this is one of the only demonstrations of this change using a pictorial medium and it thus contradicts the claim that the effect is an artefact of order of information effects (Austin *et al.*, 1977). It also refutes the suggestion that the appearance of developmental change is only apparent with the use of a verbal medium (Chandler *et al.*, 1973).

As the results also clearly show the proposed differentiation between intention and motive criteria proved to be developmentally meaningful. Therefore, in any subsequent research on the development of subjective responsibility, care should be taken to identify which of these two interpretations is under investigation. The developmental status of these alternative criteria raises a complex of issues beyond purely methodological concerns. The type of developmental change each involves depends on the context in which it is considered. In terms of Flavell's (1972) analysis of cognitive-developmental sequences, the intention criterion seems initially to be *added* to existing concepts. However, as Gutkin's (1972) results indicate, it is ultimately *substitutive* with respect to consequence considerations, and, finally, it appears to be *included* in subsequent changes in moral reasoning (cf. Kohlberg, 1969). On the other hand the use of motive as a criterion seems to *include* the developmentally earlier intention criterion but to be substituted by other criteria in subsequent developmental changes. It may not in fact be the significance of motive *per se* that is displaced later on but the significance of this particular motivational contrast of selfless *versus* selfish reasons. Designating these respectively as good and bad reasons for actions is in effect a moral judgment on the part of the investigator and one which appears to correspond to Kohlberg's (1969) third stage of moral reasoning. It is only at this stage that a superordinate moral significance is attached to this contrast. This supports the desirability of studying the effects of further types of motivational contrast on moral judgments.

An *inclusion* relationship between the intention and motive criteria seems the most likely explanation for their order of development. However, some characteristics of responses to the attribution of responsibility questions (AR) suggest the motive criterion may initially be acquired as a separate concept and only later integrated with the intention concept in a single operational structure. The difficulties that children had with story D1 in particular suggest they may be operating with two formulae which, applied to this story, yield conflicting conclusions, the formulae being " deliberate damage equals naughty etc." and " good motives equals not naughty etc." These children appear to resolve the difficulty by denying one of the premises, namely " deliberate damage ".

Of the two pairs of stories involving motive contrasts, that involving deliberate damage was significantly easier than the other. This difference was predicted on the basis of the greater degree of decentration involved in the pair involving accidental consequences; here the child must decentre from consequences which were not the goals of the character to those that were. In the former contrast this is not necessary.

Regarding the conditions for emergence of subjective responsibility criteria the hypothesis of a deficiency in capacity receives little support. Neither the insignificant correlation between the measures of causal inference and moral reasoning nor the error rates for the two measures are consistent with this hypothesis. Far fewer children have difficulties with the causal inferences than make errors on the moral judgment tasks. This is, however, consistent with the mediation deficiency hypothesis; whatever production deficiencies exist it is evident that there are also considerable mediation deficiencies.

It is also apparent that giving appropriate causal accounts of events and using appropriate designations of effects as deliberate or accidental involve quite different levels of skill. Though one may be correlated with the other the use of these responsibility attribution terms is much more closely linked to moral judgment and it may more properly be seen as an aspect of moral judgment than of description or representation skills. On the other hand, it may be a mistake to insist on any kind of absolute distinction between processes concerned with moral reasoning and those concerned with the perception and explanation of events. The well-documented evidence on what has been called immanent justice (e.g. Hoffman, 1970) provides a lesson here. That research on this phenomenon is typically discussed in the context of moral judgment tends to obscure the fact that the phenomenon concerns not moral judgment but the child's inability, under certain circumstances, to make appropriate causal inferences. The phenomenon is significant as an instance of a case in which children's immature moral intuitions lead them to distort causal relations in the service of morally satisfying conclusions.

It is likely, moreover, that not only immature forms of moral reasoning will have an influence on the child's ability to interpret events. This is evident if one considers that moral concepts can become reasons for action as well as bases for judgment. Thus, appropriate accounts of the actions of others would need to appeal to the moral concepts which underlie those actions. So far the development of moral concepts has been investigated almost exclusively in the context of moral judgment. It would seem sensible now to begin an examination of their role in the perception and explanation of social behaviour.

Finally, the preoccupation of Piagetian replication studies with the contrast between deliberate and accidental damage deserves reconsideration. Heider (1958) distinguished five forms or ' levels ' of responsibility, Global, Accidental, Incidental, Deliberate and Justified Commission. Only two of these, Accidental and Deliberate, have been studied to any extent. Justified Commission has been introduced in this study (in the guise of story pair D), but there are many other aspects of mitigation and justification which await investigation.

However, perhaps the most socially significant type of case is covered by Heider's concept of incidental commission. In everyday life we may sometimes be confronted with clear-cut cases of deliberate misdeeds and occasionally questions of justification will arise. But the most common and most problematic issues are likely to be raised in that vast grey area of carelessness, whether individuals could have foreseen the possibility of certain negative consequences arising from their actions even though these were not directly intended. It is common also in the courts; though the criminal courts may confront questions of justification and mitigation the civil courts are largely preoccupied with equally intractable questions of negligence and liability. We know next to nothing about how children develop the skills to make assessments of carelessness and liability or guilt on the grounds of negligence or foreseeable harm yet these are likely to be common problems for them. Nor do we know what they learn in terms of a layman's equivalent of the ' reasonable man ' of civil law. It is probable that in every society there is some model of the kinds of effects a person should reasonably expect to anticipate and guard against and this will reflect the kinds of risks and chance catastrophes that are routine given the prevailing technology, ecology and general conditions of life. But this important area of social life has been quite neglected by psychologists.

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SELECTING PICTURES OF ANOTHER PERSON'S VIEW

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SUMMARY. Two experiments are reported which compared different forms of presentation of a perspective-taking task. The task required 4-year-old children to select pictures showing another person's view of an array similar to Piaget and Inhelder's mountains. In Experiment 1 virtually all children failed a standard version of the task; however, 13 out of 20 succeeded when the task was preceded by preliminary questions which referred to critical attributes of the array and the pictures. These preliminary questions enabled children to adopt a successful two-stage strategy on the task. Experiment 2 replicated this finding and showed that both sets of preliminary questions were required for this effect; it also showed that when the task was presented in two stages which directly mirrored the successful strategy, virtually all children succeeded on the task. Similar results were found for 3-year-old children.

INTRODUCTION

ACCORDING to Piaget, children below the age of 7 or 8 years are unable to select pictures showing another person's view. The main evidence for this comes from the well-known mountain task (Piaget and Inhelder, 1956). In a typical version of this task the child is seated before an array of three mountains, each of which is a different colour, and a doll is placed in various positions around the array. The child is shown several pictures of the mountains and asked first to select the picture showing his own view, and then the picture showing the doll's view. Piaget and Inhelder found that although most children below 7 or 8 years could correctly select their own view, few could successfully identify the doll's view; instead, they would typically select their own view again. Piaget and Inhelder concluded from these observations that young children are extremely limited in their perspective-taking abilities: " The children . . . all really imagine that the doll's perspective is the same as their own, they all think the little man sees the mountains in the way they appear from where they themselves sit " (p. 220).

Piaget and Inhelder's observation that young children have difficulty with picture selection tasks has been replicated several times (e.g. Aebli, 1967; Dodwell, 1963; Garner and Plant, 1972). However, the Piagetian claim that this difficulty is due to lack of perspective-taking ability is more open to question, in view of several recent findings that children as young as 3 or 4 years have considerable perspective-taking abilities (see review by Flavell, 1974; also Borke, 1975). These studies have for the most part used methods other than picture selection for assessing these abilities: for example, it has been reported that children of this age can identify what another person sees when a board with pictures on each side is held vertically between the child and the other person (Masangkay *et al.*, 1974); that they can turn toys so that the other person sees a specified view of the toys (Fishbein *et al.*, 1972); and that they can rotate a replica of an array so that their view of the replica is identical to the other person's view of the array (Borke, 1975). Moreover, there are indications that very young children can, in certain circumstances, succeed on picture selection tasks. Thus if the task is greatly simplified so that the array contains only a single object, with clearly distinguishable sides, and the child is shown only a small number of pictures, then a significant number of children aged 3 and 4 years can succeed on the task (Fishbein *et al.*, 1972; Laubengayer, 1965; Lewis and Fishbein, 1969).

These findings indicate that young children's typical failure on standard picture selection tasks (such as the mountain task) cannot be due simply to lack of perspective-taking ability, as Piaget and Inhelder maintained. Instead, other explanations are needed to account for their characteristic performance on these tasks. One factor which is clearly involved is the complexity of the array: young children may succeed on a simplified perspective-taking task, yet fail with more complex materials (e.g. Flavell *et al.*, 1968). Another proposal, which will be examined here, is that young children's performance on picture selection tasks may depend on the ease with which they can identify and attend to critical attributes of the task (Fishbein *et al.*, 1972). Young children, it is argued, may solve picture selection tasks by first determining whether certain attributes of the array are visible to the other person, and then selecting the picture showing the appropriate attributes. However, young children may have difficulty in identifying these critical attributes by themselves, and may only attend to them if they are pointed out by the experimenter. On this view, then, it would be predicted that children's performance on a picture selection task may improve if their attention is first drawn to the critical attributes of the task.

This prediction is examined in the first experiment reported here. The array resembles that of Piaget and Inhelder's mountain task in that it consists of three similar objects of different colours. Here, however, the objects are dolls, and each doll faces outwards from a different corner of a triangular base. The array is placed between the experimenter (*E*) and the child so that the child sees the face of the doll nearest to him, while *E* sees the face of a different doll, the one nearest to him. The child is shown a set of pictures of the array, and the task is to select the one showing *E*'s view (see Figure 1).

With this array children can succeed on the task by adopting a strategy based on the dolls' faces. That is, a successful strategy is as follows:

Stage 1: the child calculates which doll's face *E* sees;

Stage 2: the child selects the picture showing this doll's face.

Thus the dolls' faces are critical attributes of the task, and the successful strategy links these attributes of the array (which doll's face is visible to *E*) to the corresponding attributes of the pictures (which doll's face is visible in each picture). However, as argued above, children may only attend to these attributes if they are pointed out by the experimenter. Accordingly, in one condition of Experiment 1 children received preliminary questions in which they were asked, for each position of the array, which doll's face they themselves could see and which doll's face *E* could see; they were also asked which doll's face was visible in each picture. In the other condition children received no preliminary questions. It was predicted that the children who received preliminary questions would show higher performance on the task.

EXPERIMENT 1

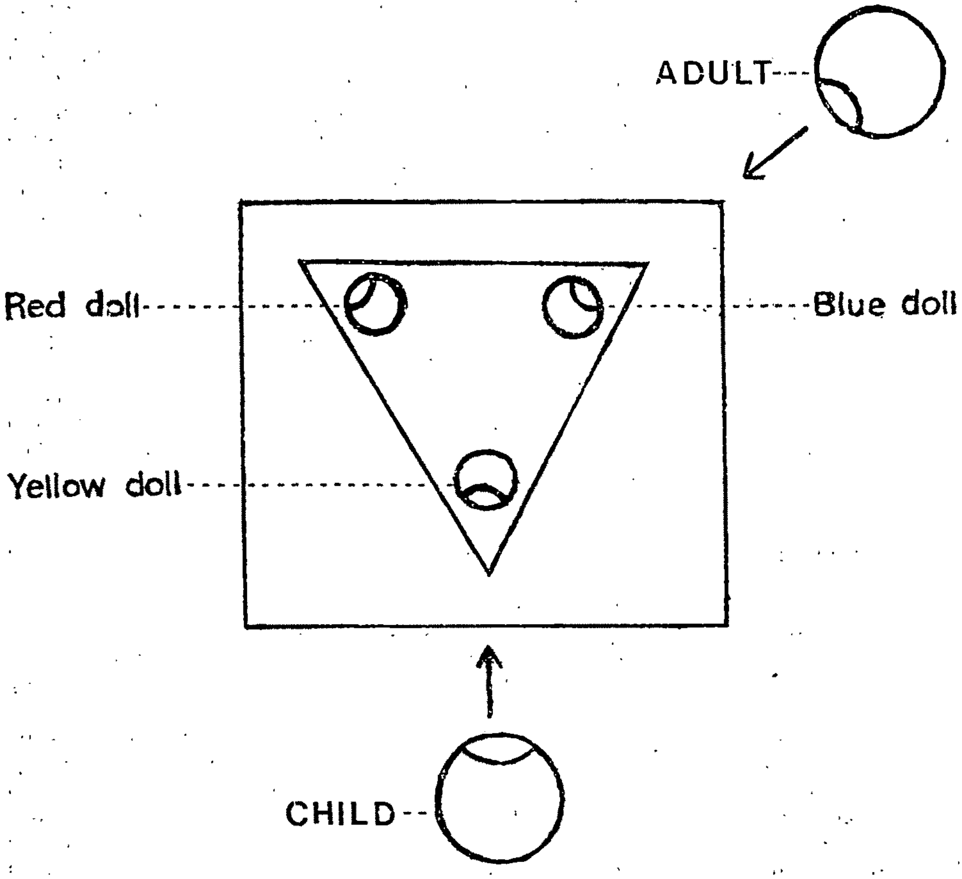
Sample

The sample consisted of 40 pre-school children, 22 boys and 18 girls, aged 4:0 to 4:10 (mean: 4:5). They all attended part-time nursery school in Edinburgh and were of mixed social class.

Materials

The array consisted of three coloured dolls (red, blue and yellow), 15 cm high, with prominent faces. They were each mounted near a corner of a triangular base 5 cm high and side length 30 cm. Each doll faced outwards from its corner of the base. The dolls were placed on a table in front of the child. The base was always in one of three positions, i.e. with either the red doll, the blue doll, or the yellow doll facing the child. The experimenter (*E*) also sat at the table, oriented at 120° to the child. Thus for each position of the base the child saw the face of the doll nearest him, and side views of the other two dolls. Similarly, *E* saw the face of the doll nearest *him*, and side views of the other two dolls (see Figure 1).

FIGURE 1
TYPICAL ARRANGEMENT OF MATERIALS (PLAN VIEW)



There were three pictures of the array, each 15 cm × 10 cm, fixed on a board 36 cm × 15 cm. The pictures showed the three views corresponding to the three positions of the base. Thus for each position of the base, one picture showed the child's view, one showed *E*'s view, and one showed a third view.

Procedure

The children were divided into two groups of 20, matched as far as possible for age and sex. One group, condition A, received picture selection questions only (*PS only*). The other group, condition B, received preliminary questions before the picture selection questions (*PQ and PS*). Each child was individually tested by the same (male) experimenter. No feedback or knowledge of results was given.

Condition A (*PS only*). All children received three picture selection questions about their own view (*PS own view*), followed by three picture selection questions about *E*'s view (*PS other view*). For PS (own view) *E* showed the pictures to the child and said: " These are three pictures of the dolls. Look at the dolls. Now look at the pictures. *Which picture shows what you see?* " After the child responded *E* said " O.K.", rotated the array, and repeated the question for the other two positions of the base. For PS (other view) E said: " This time *I* am looking at the dolls. *Which picture shows what I see?* " After the child responded E rotated the array and repeated the questions for the other two positions of the base.

It should be noted that this particular wording of the picture selection question is ambiguous, in that there is a sense in which " what E sees " is simply " the array ", and so *any* picture of the array shows " what E sees ". However, a pilot study for this experiment compared the present wording: (a) " *which picture shows what you see/what I see?* " with two different wordings: (b) " *which picture shows how it looks to you/to me?* " and (c) " *which picture shows the doll's face that you see/I see?* ", both of which are less ambiguous than (a) but are linguistically more complex. Performance was slightly higher with (a) but the differences were not significant.

Condition B (PQ and PS). All children received three preliminary questions about their own view (*PQ own view*), three preliminary questions about E's view (*PQ other view*), and three preliminary questions about the pictures (*PQ pictures*). For PQ (own view) no pictures were present and E asked " *which doll's face do you see?* " for each position of the base. For PQ (other view) there were again no pictures present and E asked " *which doll's face do I see?* " for each position of the base. For PQ (pictures) the dolls were removed from the table and only the pictures were shown; E asked " *which doll's face do you see in this picture?* " for each picture in turn. Half the children received PQ (own view), then PQ (other view), then PQ (pictures), while the other half received PQ (pictures), then PQ (own view), then PQ (other view). After these preliminary questions all children received PS (own view) and PS (other view) exactly as in condition A.

RESULTS AND DISCUSSION

A criterion was set of two or more questions correctly answered out of each block of three questions. Table 1 shows the number of children, out of 20 in each group, who reached the criterion for each set of questions.

TABLE 1

NUMBER OF CHILDREN REACHING CRITERION IN EXPERIMENT 1

Condition	PQ own view	PQ other view	PQ pictures	PS own view	PS other view
A	—	—	—	12	1
B	20	19	16	13	13

N=20 in each condition

As can be seen from Table 1, performance in condition A (no preliminary questions) was very similar to that typically found in standard picture selection tasks. That is, the majority of children (12 out of 20) could select pictures showing their own view, but only one child could select pictures of E's view. Almost two thirds of the errors (64 per cent) on PS (other view) were ' egocentric ' errors, i.e. the child selected his own view of the array instead of E's view.

In contrast, performance in condition B was quite different. Performance was very high on all preliminary questions, with 20, 19 and 16 children succeeding on PQ (own view), PQ (other view) and PQ (pictures) respectively. In particular, performance on PQ (other view) in this condition was significantly higher than performance on PS (other view) in condition A ($\chi^2=28{\cdot}9$; df$=1$; $P<0{\cdot}001$). Thus children of this age can identify which doll's face *E* can see, yet are unable to select a picture of *E*'s view when presented with the standard picture selection task.

Performance on the picture selection task, however, is greatly improved by the preliminary questions. Thirteen children out of 20 succeeded on PS (other view) in condition B, compared with only one child in condition A ($\chi^2 = 13{\cdot}3$; $df = 1$; $P < 0{\cdot}001$). Thus, as predicted, the preliminary questions have a strong effect on performance, and result in almost two-thirds of the children succeeding on the picture selection task.

In addition, Experiment 1 provides informal evidence that most children who succeeded on picture selection were using the two-stage strategy outlined above. Many children in condition B, when correctly selecting a picture showing *E*'s view, made reference to whichever doll's face *E* saw, either by pointing, or verbally, or both. For example, if the dolls were positioned so that *E* was looking at the blue doll's face, the child would point to the blue doll saying " You see this one's face " and then select the correct picture. Moreover, this kind of referring was still done by children in condition B who *failed* picture selection. For example, a child would correctly say " You see the blue doll's face " and then select an incorrect picture. At the same time the child would point, in the picture chosen, to the blue doll: however, as this was an incorrect choice, only the side view of the blue doll would be visible in the picture. In terms of the strategy outlined above, these children seem to be adopting only the first stage of the strategy and failing on the second stage.

Thus the results of Experiment 1 show that, although 4-year-old children typically fail on a standard picture selection task, the majority of these children can succeed on the task if it is preceded by preliminary questions which require the child to identify and attend to critical attributes of the task. These preliminary questions increase the likelihood of the child adopting a successful task strategy.

The next experiment was intended to clarify and extend these findings in several ways. First it attempted to replicate, using a slightly different design, the effect of the preliminary questions found in Experiment 1, and to investigate whether both PQ (views) and PQ (pictures) are required for this effect.

Secondly it examined further ways of presenting the picture selection task. If the children who succeeded on picture selection in Experiment 1 did so by adopting the intended strategy, then this suggests that performance might be enhanced if the whole picture selection procedure were redesigned to mirror the strategy directly. That is, the child could be asked, for a given position of the array, which doll's face *E* could see; if he responded correctly then he could be immediately asked to select the picture showing *E*'s view. This method was adopted in some conditions of Experiment 2, and two variants on this procedure were systematically explored. First, a comparison was made between two different wordings of the immediately following picture selection question: " *Which picture shows what I see?* " was compared with " *Which picture shows the doll's face that I see?* " Secondly, as the redesigned procedure incorporates PQ (views) but not PQ (pictures), the effect of a preliminary set of PQ (pictures) on the procedure was also examined.

Finally, although the next experiment was primarily concerned with the performance of 4-year-olds, some conditions were also given to a smaller number of 3-year-olds.

EXPERIMENT 2

Sample

The sample consisted of 263 children (139 boys and 124 girls) from Edinburgh nursery schools. For the older group (N = 216) the age range was 4:0 to 5:3 (mean: 4:6); for the younger group (N = 47) the age range was 3:1 to 3:11 (mean 3:8). The subjects were of mixed social class, and none were subjects for Experiment 1.

Design

There were two parts to the experiment, separated by one to two weeks. In Part I all 263 children were given picture selection questions exactly as in condition A of Experiment 1. Of these, 39 children (36 older, 3 younger) who spontaneously reached the criterion of two correct responses out of three were not retested, and a further 28 children (20 older, 8 younger) were not available for Part II. The remaining 196 children (160 older, 36 younger) all of whom had failed on Part I, proceeded to Part II. The older children were divided into eight groups of 20 children (matched as far as possible for age and sex) who received conditions A to H. The younger children were divided into three groups of 12 children (matched as far as possible for age and sex) who received conditions D, F and H. Each child received one condition only in Part II.

Materials

The same materials were used as in Experiment 1.

Procedure

Children were individually tested by the same (male) experimenter, who gave no feedback or knowledge of results. The sets of questions used in conditions A to H are shown in Table 2.

Conditions A to D resembled condition B of Experiment 1 in that they each consisted of two sets of three picture selection questions (PS own view and PS other view), preceded by various sets of preliminary questions. In condition A the preliminary questions were control questions about formally irrelevant topics (such as questions about the identical aprons the dolls were wearing); in condition B the preliminary questions were PQ (pictures); in condition C they were PQ (views); and in condition D they were PQ (views) and PQ (pictures). Thus condition D constituted a direct replication of the facilitation effect found in Experiment 1, while conditions B and C indicated which sets of preliminary questions were needed to produce the effect, and condition A controlled for the possibility that *any* set of preliminary questions might have a facilitative effect on subsequent performance.

In conditions E to H the PS questions were presented in the alternative form outlined above. In condition E the experimenter started with the pictures face down and asked " *Which doll's face do you see?* " After the child responded (and whether or not the response was correct) *E* immediately showed the pictures and asked " *So which picture shows what you see?* " This was repeated for the other two positions of the array. Then *E* repeated this for his own view. With the pictures face down he asked " *Which doll's face do I see?* ", and after the child responded he immediately showed the pictures and asked " *So which picture shows what I see?* " This was repeated for the other two positions of the array. This basic procedure used in condition E is referred to as PS*. Condition F was identical to condition E except that PS* was preceded by PQ (pictures). Condition G was identical to condition E except that the wording used was " *So which picture shows the doll's face that you see?* " and " *So which picture shows the doll's face that I see?* " (referred to as PS**). Condition H was identical to condition G except that PS** was preceded by PQ (pictures).

RESULTS

Table 2 shows the number of children in the older group (out of 20 in each condition) who reached the criterion of two or more correct responses out of a set of three questions.

The results from conditions A to D confirm and extend the findings of Experiment 1. In condition D, where the PS questions were preceded by PQ (views) and PQ

TABLE 2

NUMBER OF 4-YEAR-OLD CHILDREN REACHING CRITERION IN EXPERIMENT 2

Condition	PQ own view	PQ other view	PQ pictures	PS(*)(**) own view	PS(*)(**) other view
A	—	—	—	8	2
B	—	—	20	14	4
C	20	20	—	12	6
D	20	19	19	15	16
E	—	—	—	19	17
F	—	—	20	20	20
G	—	—	—	19	19
H	—	—	20	19	18

N=20 in each condition

(pictures), 16 out of 20 children succeeded on PS other view: all of these children had previously failed on the standard PS task in Part I. Comparison of conditions A to D shows that this effect only occurs when both sets of PQ are present. Performance on condition A (2 out of 20 succeeding on PS other view), on condition B (4 out of 20 succeeding) and on condition C (6 out of 20 succeeding) does not differ significantly from chance responding, nor do these conditions differ significantly from each other; however, performance on condition D (16 out of 20 succeeding) differs significantly from both chance ($\chi^2=9{\cdot}6$; $df=1$; $P<0{\cdot}01$) and from condition A ($\chi^2=17{\cdot}1$; $df=1$; $P<0{\cdot}001$), condition B ($\chi^2=12{\cdot}1$; $df=1$; $P<0{\cdot}001$) and condition C ($\chi^2=8{\cdot}2$; $df=1$; $P<0{\cdot}01$).

The results from conditions E to H show uniformly high performance. Virtually all children succeed in all conditions, with no significant effects due either to the presence of PQ pictures (condition E compared with F, G compared with H) or to the difference in wording between PS* and PS** (condition E compared with G, F compared with H). Thus when the picture selection questions were presented so that they directly mirrored the successful strategy, virtually all the children were successful.

TABLE 3

NUMBER OF 3-YEAR-OLD CHILDREN REACHING CRITERION IN EXPERIMENT 2

Condition	PQ own view	PQ other view	PQ pictures	PS(*)(**) own view	PS(*)(**) other view
D	12	10	12	10	9
F	—	—	12	10	10
H	—	—	10	11	11

N=12 in each condition

Table 3 shows comparable data from the younger group (3-year-olds) for conditions D, F, and H. The 3-year-olds were virtually all successful on all these conditions, and there were no significant differences in performance between the 3- and 4-year-olds.

DISCUSSION

The findings of Experiment 2 thus confirm and extend the findings of Experiment 1, and indicate that the way in which the picture selection task is presented to the child strongly influences the child's performance on the task. In particular the present findings show that children of this age can succeed on a picture selection task by adopting a strategy which links attributes of the array to corresponding attributes of the pictures. That is, children can succeed on the task by first identifying which attribute of the array is visible to the other person, and then selecting the picture showing this particular attribute. It seems, however, that young children do not adopt this kind of strategy spontaneously, but only when the picture selection questions are preceded by questions which require the child to identify which aspects of the array are visible to themselves and to the other person, and to identify which attributes are visible in each of the pictures (condition B of Experiment 1; condition D of Experiment 2). Moreover children do not adopt this successful strategy unless both sets of preliminary questions are presented (conditions B and C of Experiment 2). Thus it would seem that young children are only able to develop and adopt an appropriate strategy—that is, one that links up attributes of the array with corresponding attributes of the pictures—if they are first required to identify and attend to those attributes on *both* the array and the pictures: identifying and attending to one set of attributes alone is insufficient.

When the task is presented in a form which directly mirrors this successful strategy (conditions E to H of Experiment 2), then almost all 3- and 4-year-olds succeed on the task. With this form of task presentation the child is first asked which attribute of the array is visible to the other person (*E* says " *Which doll's face do I see?* "); when the child responds (and virtually all children responded correctly) he is immediately given the picture selection question (" *So which picture shows what I see?* "). Here the task is presented in two stages and so the child does not have to develop the two-stage strategy himself; instead, it is assumed that his response to the first question is still available to him when he is given the second question, and thus the task reduces to selecting the picture showing the attribute he has just named. This form of task presentation seems particularly robust, for the high levels of performance are unaffected either by variation in the wording of the picture selection question (conditions G and H), or by the presence or absence of preliminary questions about attributes of the pictures (conditions F and H).

This finding that PQ (pictures) are unnecessary with the two-stage form of presentation contrasts interestingly with the finding that PQ (pictures) are essential for success with the form of presentation used in conditions A to D. However, these two findings are by no means discrepant, but accord with the accounts just given. Thus, with the two-stage form of presentation (conditions E to H), once the child has identified which attribute is visible to the other person he has only to select the picture showing this attribute in order to succeed on the task; he can presumably accomplish this relatively simple matching procedure without prior questioning about the attributes of each picture. In contrast, the more standard form of task presentation used in conditions A to D requires the child himself to develop the two-stage strategy linking attributes of the array to attributes of the pictures. This is a somewhat more demanding task, which it would seem the child can only accomplish after prior focusing on attributes of both the array and the pictures.

The present study leaves unresolved the question of why children do not spontaneously adopt the successful strategy when presented with the standard picture selection task; or, in other words, why the preliminary questions are needed at all. This calls for a more detailed consideration of the precise functions of the preliminary questions. The most straightforward view would be that with standard presentations of the picture selection task the young child clearly understands the nature of the task (i.e. that one of the pictures shows *E*'s particular view of the array and that he must discover which one it is), but that he does not quite know how to proceed. On this view the preliminary questions simply serve to draw the child's attention to critical attributes of the array and pictures, which he then incorporates into the successful strategy. An alternative view, however, is that the child's understanding of the standard form of the task may not be complete. For example, he may interpret the instructions as requiring him only to consider *what* the experimenter sees (i.e. the array) and not *how it looks* to him (i.e. the experimenter's particular view of the array). Indeed, in view of the ambiguity in the instructions noted earlier, such an interpretation would be quite legitimate. In addition, the child may not fully understand that the pictures represent three distinct views of the array; he may believe they are to some extent interchangeable, or even that they show three different arrays. On this view, the preliminary questions serve a dual role; not only do they draw the child's attention to critical attributes of the task, but they may also clarify the child's understanding of particular aspects of the task. Thus PQ (views) may not only draw the child's attention to critical attributes of the array, but, by requiring the child to attend to differences between his view of the array and the experimenter's view, may indicate to the child that the task is concerned with such differences between views. Similarly PQ (pictures) may not only draw the child's attention to critical attributes of the pictures, but by emphasising such differences between the pictures, may indicate to the child that the pictures represent different views of the array. Clearly, further work is required to distinguish between these accounts—for example, by using preliminary questions which clarify the task for the child but do not draw the child's attention to critical attributes of the task.

The present findings have important implications for the study of young children's perspective-taking abilities. They show that failure on a standard picture selection task may not necessarily be due to lack of perspective-taking ability, as Piaget and Inhelder (amongst others) have claimed, since performance on the task seems to be strongly influenced by the manner of task presentation used. Here virtually all 3- and 4-year-old children failed when asked, in the standard manner, to select a picture showing the experimenter's view of an array similar to Piaget and Inhelder's mountains: a result in accord with much previous work in this area. Yet these children did not lack the perspective-taking skills needed to succeed on the task, for when the task was presented in alternative forms the majority of children (and in some cases virtually all children) succeeded on the task. Thus it appears that the standard picture selection procedure originally developed by Piaget and Inhelder and used many times since may seriously misrepresent young children's perspective-taking abilities, and that claims about such abilities which are based on this procedure are open to considerable doubt. Instead it would seem that the form of task presentation, a factor which has received little attention in previous work, is of crucial importance in determining young children's performance on such tasks.

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THE EFFECTS OF QUANTITATIVE FEEDBACK ON CHILDREN'S EXPECTATION OF SUCCESS

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SUMMARY. A pair of studies conducted with first, third, and fifth graders supports the prediction that concrete, quantitative feedback, as opposed to qualitative comments, increases the validity of children's expectations of their level of performance. Children were presented with a series of puzzles on which they worked under different feedback conditions. The validity of expectations was examined under two conditions, and also the attributions they made for their levels of performance. These data also confirm previous findings which indicate that overestimation of levels of performance decreases with age. In addition it was found that children's attribution of success to ability decreased with age. Few children at any grade level attributed their performance on these particular puzzles to luck, as opposed to effort.

INTRODUCTION

THE positive effects of feedback on children's performance have been well substantiated (Greenwood *et al.*, 1974; Tait *et al.*, 1973; Foreit, 1974). Explanations for these effects, however, vary. Skinnerians argue that feedback has reinforcing properties which account for improved performance. Others have demonstrated that it is the correctional value of feedback which explains behaviour improvement (Smallwood and Arnoult, 1974; Levy, 1974). Still others argue, consistent with Tolman, that feedback influences expectation which in turn operates as a major determinant of performance. The latter argument is impressively presented by Bolles (1972) who discusses empirical data from animal research which defies reinforcement theory but is consistent with his theory of expectation. He proposes that there are primary and secondary expectancies (distinguishable in terms of their biological or learned origins) and that the compatibility or incompatibility of these expectancies determines behaviour. Bolles argues, for example, that a pigeon has a primary or biological-oriented expectancy which associates pecking behaviour with hunger satisfaction, thus it is relatively easy, through reinforcement techniques, to establish the expectancy, 'pecking the lighted disc results in food'. On the other hand, this same biologically oriented expectancy makes it virtually impossible to develop the learned expectancy, 'not pecking the lighted disc results in food'. Reinforcement has proven ineffective for establishing behaviours which are contrary to biologically-oriented expectancies (e.g. not pecking in order to obtain food reinforcers) (Williams and Williams, 1969; Breland and Breland, 1961).

Bolles' theory, like the Expectancy × Valence theories of social psychologists (e.g. Festinger, Atkinson), assumes the importance of accurate expectations. But, unlike most expectancy theorists, Bolles clearly acknowledges that our lack of knowledge regarding the nature and determinants of expectations is a major limitation of such theories. He recognises the need for identifying 'factors which can prevent an expectancy from matching perfectly with the corresponding contingency', and argues, 'A general rule for how accurately expectancies match contingencies, therefore, must ultimately implicate the entire subject matter of psychology' (p. 408).

An examination of the developmental nature of children's expectation provided evidence that Validity of Expectation (defined as a measure of conformity between an expectation and previous relevant performance) increases with age (Clifford, 1975). It must be made clear that Validity of Expectation is distinguished from Predictive Value of Expectation which is a measure of conformity between an expectation and subsequent performance. Validity of Expectation is the absolute difference between previous performance and expectation; therefore, the lower the value, the greater the Validity or accuracy. In this study a high incidence of overestimation, particularly among first and third graders, in contrast to fifth graders, was also reported. It was postulated that the ability to process feedback may, in part, account for this developmental phenomena. Consistent with this reasoning, it was suggested that a provision for concrete, numeric feedback may facilitate feedback processing, and therefore, increase Validity of Expectation for young children. It was for the purpose of testing this prediction (i.e. concrete, numeric feedback increases Validity of Expectation) that the following pair of studies was conducted. Of secondary interest was the assessment of the nature of children's attributions for their success (for ethical reasons attribution for failure was not investigated).

METHOD

Sample

Ninety first and third graders participated in Study I and 193 first, third, and fifth graders were included in Study II. The second study was conducted because fifth grade students from the initial sample who were expected to participate were unable to do so. The grade distribution of the samples are presented in Tables 1 and 2. The ratio of boys to girls was, in all groups, close to one.

Materials

Four symmetrical designs each consisting of 30 geometric shapes adjacently affixed to a 10 1/2″ × 14″ white cardboard were used in Study I. These designs, referred to as ' puzzles ', contained cardboard pieces of seven shapes and six colours. Each of the four puzzles consisted of a unique arrangement of 30 such pieces. A set of matching puzzle pieces intended for the replication of puzzles by the subject was also prepared.

The materials for Study II were similar with the following exceptions. There were only 24 pieces involving three shapes and six colours. Puzzle pieces used by the subjects were made of wood 5/8″ thick as opposed to cardboard. These changes were made to reduce task complexity and facilitate the manipulation of puzzle pieces.

Procedure

Although the experimental task was administered to subjects individually, task instructions were presented to intact classrooms. Students were shown a sample puzzle and the set of matching pieces. They were told that ' working a puzzle ' meant arranging the loose puzzle pieces on the desk (or table) according to the picture presented on the white cardboard. A brief demonstration was made in which several children were allowed to place a piece in the puzzle. Students were told they would later have a chance to work several similar puzzles but would be given only a little time for each one. It was explained that the experimenter wanted to see how many pieces each child could place correctly in the allotted time (i.e. 30 seconds per puzzle in Study I and 40 seconds in Study II).

Children were individually tested after being randomly assigned to one of two conditions: the *Control* group was presented with each of the four puzzles in an invariant order and allowed the appropriate amount of time to work each. After each of the first three puzzles, the child was simply asked to move all the pieces to one side of the work table and prepare for the next puzzle. Before beginning the fourth puzzle, the subject was asked, ' How many pieces do you think you will place correctly before I tell you to stop? ' Following the elicitation of this expectation, the experimenter presented the final puzzle. After the allotted time, the experimenter assisted the child in counting the correctly placed pieces and asked, ' If you were to work one more puzzle, how many pieces do you think you could place correctly? ' Following the elicitation of this second expectation, the child was told he did not have to work another puzzle and that he had done very well ' for a first (third, fifth) grader, especially on some puzzles '.

In an attempt to assess whether success was attributed to self or other factors (i.e. whether the individual tended to make internal or external locus of control responses) the subject was asked the following two questions: ' Was this because you are pretty good at these kinds of tasks or because this is an easy task? ' and, ' Was it because you tried hard or because you were lucky? ' The order of the questions was held constant across children but the order of the options within each question was counterbalanced. These questions were intended to assess the subject's attributions in terms of the stable (ability *versus* task difficulty) and non-stable (effort *versus* luck) components emphasised in Weiner's (1974) classification scheme for perceived determinants of achievement behaviour. The forced choice format of these questions was not unlike that used in previous research (McMahan, 1973); it was preferred over independent ratings of each factor because the latter was judged to be too difficult for young children. The experimenter unobtrusively recorded performance on each puzzle, the subject's expectations, and his attribution responses.

The *Feedback* group was treated like the control group with the exception that the children were presented with a record sheet consisting of four rows (corresponding to the four puzzles) each containing 30 or 24 adjacent squares clearly numbered (corresponding to number of puzzle pieces). They were told that after working each puzzle, the experimenter would cross out one square for every piece the children had correctly placed in a given puzzle. Thus, after each puzzle was completed, the experimenter counted aloud the correctly placed pieces and recorded performance in the appropriate row on the record sheet which remained in the upper right hand corner of the work table. After eliciting the child's expectation for the fourth puzzle, the experimenter recorded that number on the exposed record sheet and proceeded as in the control condition.

Dependent Variables

The six major dependent variables are defined and symbolised as follows: The first measure of Validity of Expectation (E_{V1}) which is the absolute difference between a child's average performance on puzzles two and three and his first expectation obtained prior to the presentation of puzzle four; the second measure of Validity of Expectation (E_{V2}) which is the absolute difference between performance on puzzle four and the second expectation; the Directional Discrepancy scores associated with each of the performance-expectation differences identified above (D_1 and D_2 respectively); the first attribution response (A_1); and the second attribution response (A_2). The latter two were dichotomous variables for which response frequency was tallied. Performance scores (number of pieces correctly placed for each puzzle) were considered relatively unimportant and expected to reflect little more than grade effects. Treatment effects on performance were not anticipated because the puzzle task was assumed to be of high interest and was expected to elicit maximum effort and performance under both conditions. Expectancy scores were judged important only in so far as they were needed to compute the difference scores of major interest.

RESULTS AND DISCUSSION

Least squares analyses of variance (allowing for disproportional group size) were used to examine most of these data. The descriptive statistics for the four discrepancy measures for each of the two studies are provided in Tables 1 and 2. Figure 1 contains a graphic presentation of the Validity of Expectation and Directional Discrepancy Score findings. Positive values for D_1 and D_2 variables indicate overestimation

TABLE 1

MEANS OVER STANDARD DEVIATIONS FOR STUDY I

Group	N	E_{V1}	D_1	E_{V2}	D_2
C 1	24	1·96	1·79	0·83	0·50
		2·18	2·32	1·01	1·21
C 3	23	2·22	1·87	0·78	0·00
		1·98	2·32	0·80	1·13
F 1	24	1·46	1·30	1·17	0·67
		1·59	1·73	1·20	1·55
F 3	19	0·89	0·68	1·42	−0·58
		0·99	1·16	1·22	1·80
Control	47	2·09	1·83	0·81	0·26
		2·06	2·30	0·90	1·19
Feedback	43	1·21	1·02	1·28	0·12
		1·37	1·52	1·20	1·76
Grade 1	48	1·71	1·54	1·00	0·58
		1·90	2·04	1·11	1·38
Grade 3	42	1·62	1·33	1·07	−0·26
		1·72	1·96	1·05	1·48

TABLE 2

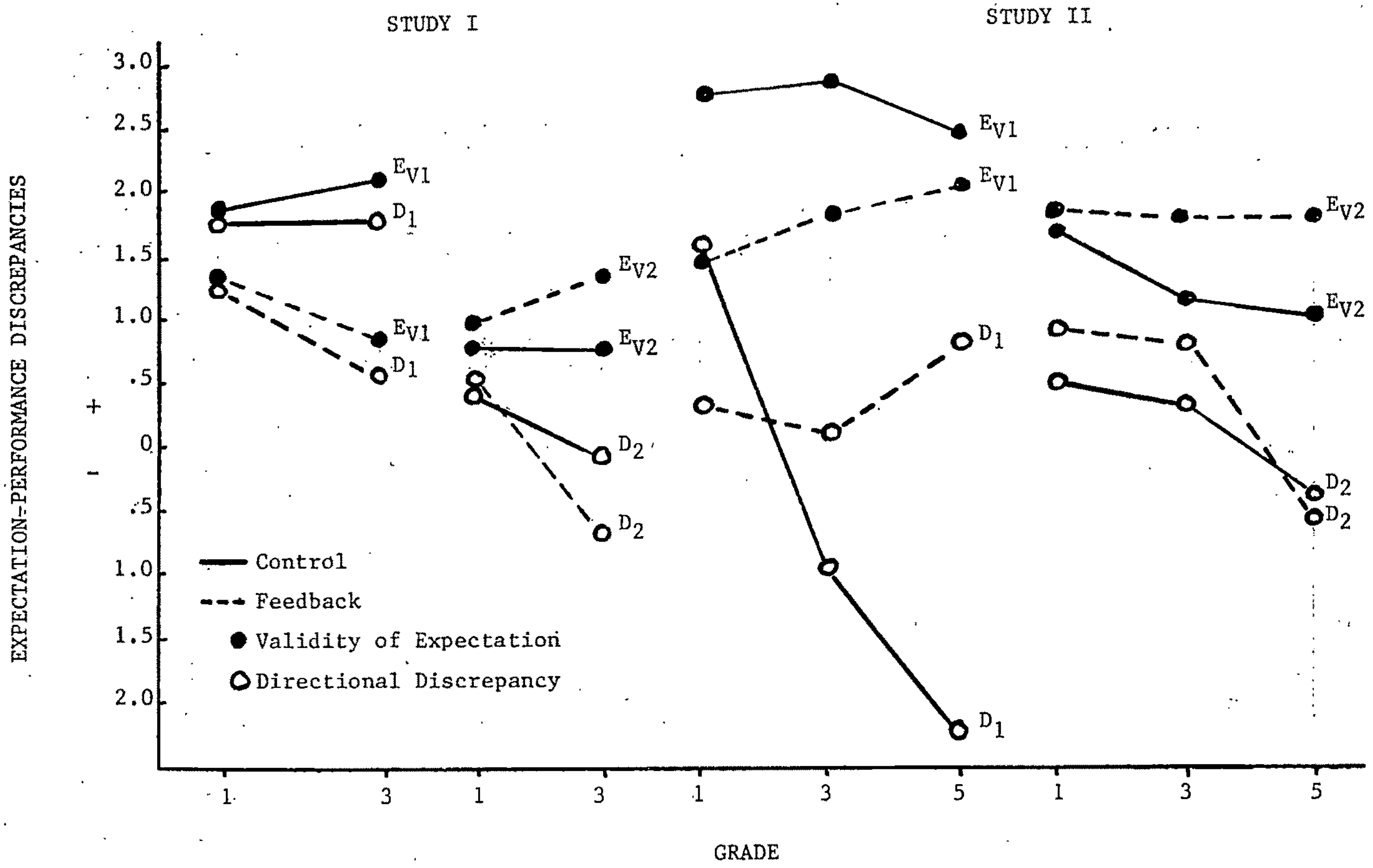
MEANS OVER STANDARD DEVIATIONS FOR STUDY II

Group	N	E_{V1}	D_1	E_{V2}	D_2
C 1	32	2·84	1·71	1·75	0·56
		3·28	4·01	2·31	2·86
C 3	36	2·92	−0·81	1·25	0·47
		2·31	3·66	1·52	1·92
C 5	32	2·56	−2·25	1·19	−0·37
		1·98	2·34	1·23	1·68
F 1	31	1·48	0·39	1·97	1·00
		1·57	2·14	1·82	2·50
F 3	34	1·82	0·23	1·79	0·85
		1·24	2·22	1·95	2·52
F 5	33	2·15	−0·88	1·85	−0·51
		1·86	2·72	1·39	2·28
Control	100	2·78	−0·46	1·39	0·23
		2·55	3·76	1·74	2·22
Feedback	98	1·83	−0·09	1·87	0·44
		1·58	2·42	1·72	2·51
Grade 1	63	2·19	1·00	1·83	0·76
		2·64	3·29	2·07	2·66
Grade 3	70	2·38	−0·30	1·51	0·66
		1·94	3·07	1·75	2·23
Grade 5	65	2·35	−1·55	1·52	−0·45
		1·91	2·62	1·35	1·99

(i.e., expectation > previous performance) and negative values represent underestimation (i.e. expectation < previous performance). Validity of Expectation is plotted on the positive side of the scale. There was a Treatment main effect for E_{V_1} in Study I ($F = 5{\cdot}48$; $P < {\cdot}05$) as well as Study II ($F = 9{\cdot}78$; $P < {\cdot}002$). As predicted, children in the control group expressed less valid expectations than did those in feedback group. An unexpected reversal was observed for E_{V_2}. In Study I children in the control group were significantly more valid than feedback subjects ($F = 4{\cdot}33$; $P < {\cdot}05$); in Study II a similar but non-significant trend was also observed ($F = 3{\cdot}69$; $P < {\cdot}06$). However, it can be argued that numeric feedback was a determinant of E_{V_2} in *both* conditions, for the experimenter always counted the number of correctly

FIGURE 1

MEAN SCORES FOR VALIDITY OF EXPECTATION (E_V) (PLOTTED AS POSITIVE VALUES) AND DIRECTIONAL DISCREPANCY (D) SCORES FOR STUDIES I AND II



Note: The lower the Ev score, the greater the validity or accuracy of the expectation. Positive discrepancy scores indicate overestimation and negative scores indicate underestimation.

placed pieces for the fourth puzzle and therefore, both control and feedback children received numeric feedback before stating their second expectation. The only difference between the conditions was in the overt recording of performance for children in the feedback group.

Consistent with the major prediction of the study, children in the control group formulated more valid expectations following a single piece of numeric feedback ($E_{V_2} = \cdot 81$ and $1 \cdot 39$ in Studies I and II respectively) than they did prior to receiving such feedback ($E_{V_1} = 2 \cdot 08$ and $2 \cdot 78$ in Studies I and II respectively). Children in the control group (in comparison to the feedback group) may have reacted more strongly to the expectancy-performance discrepancy brought to their attention with puzzle four feedback because the magnitude of the discrepancy was relatively greater. That is, there was a tendency toward greater over- and underestimation (D_1) among control as opposed to feedback subjects. Furthermore, feedback children whose performance was numerically recorded after every trial, were conscious of performance changes and may have implicitly been formulating expectancies and experiencing expectancy-performance discrepancies throughout the experiment. They may, therefore, have been relatively less responsive and more conditioned to the discrepancy experienced just prior to the elicitation of the last expectation.

Grade main effects for D_2 ($F = 7 \cdot 73$; $P < \cdot 01$) in Study I and D_1 ($F = 12 \cdot 61$; $P < \cdot 001$) and D_2 ($F = 5 \cdot 45$; $P < \cdot 005$) in Study II support previous findings that indicate overestimation decreases with age. No grade effect was observed for D_1 in Study I (involving first and third graders only); but it is not surprising that developmental trends are less consistent as levels within the developmental continuum are decreased.

A Treatment × Grade effect for D_1 in Study II ($F = 3 \cdot 99$; $P < \cdot 02$) suggests that while feedback reduces overestimation among first graders, it reduces underestimation among third and fifth graders. While a comparable interaction was not observed in Study I, there was a treatment trend for D_1 ($F = 3 \cdot 77$; $P < \cdot 06$) suggesting feedback reduces overestimation for first and third graders. No other main effects or interactions were observed for any of the four major discrepancy variables.

An analysis of the frequency with which first and third graders in Study I attributed success to ability (i.e. 'being pretty good') as opposed to task ease resulted in a χ^2 for A_1 of $4 \cdot 59$; $P < \cdot 05$. While 58 per cent of the first graders attributed success to ability, only 36 per cent of the third graders did so. A similar analysis for Study II yielded $\chi^2 = 8 \cdot 98$; $P < \cdot 05$; the frequency with which success was attributed to ability decreased from 64 per cent in grade 1 to 58 per cent in grade 3 to 39 per cent in grade 5. In neither study did χ^2 analyses on A_2 (effort *versus* luck attribution) result in significance; only a very few subjects attributed outcomes to luck. These results, especially the small percentage of ability attributions observed in the higher grades, are somewhat inconsistent with studies which indicate success is generally attributed to one's own control (Jenkins and Ward, 1965) or, more specifically, attributed to ability as opposed to task characteristics (Frieze and Weiner, 1971). However, if one assumes this puzzle task was perceived as relatively easy by older students, the data are compatible with those which indicate that while both effort and ability are used to explain success on relatively difficult tasks, either is sufficient to explain success on easy tasks (Kun and Weiner, 1973). Another explanation for these attribution responses may lie in a socialisation process through which children become increasingly reluctant to 'brag' or admit they are 'good', 'smart', etc., but show no hesitancy in acknowledging an expenditure of effort—a socially desirable characteristic.

In summary, numeric feedback—visual as well as auditory—increased Validity of Expectation for young children. The absence of quantitative feedback appears to be one factor 'which can prevent an expectancy from matching perfectly with the corresponding contingency' (Bolles, 1972, p. 408). If expectation plays as important a role in determining behaviour as has been postulated and demonstrated by motivation theorists, these findings may have important implications for education.

There is now evidence that both age (Clifford, 1975) and nature of feedback as manipulated in the present study significantly affect Validity of Expectation and, therefore, any assumption regarding the accuracy of expectations appears unwarranted at least for children. Thus, a question of theoretical importance is, 'Can Expectancy × Valence theories contend with inaccurate as well as accurate expectations?' If not, the applicability of such theories may differ markedly for children and adults. A question of practical concern is, ' Does increased Validity of Expectation facilitate classroom learning and performance? ' If so, perhaps more quantitative as opposed to qualitative feedback should be provided students—a practice somewhat contrary to recent trends.

Given the absence of a treatment effect for puzzle performance in the present study, one might conclude there is little relationship between Validity of Expectation and performance. However, such a conclusion would be premature. The puzzle task was chosen because it could be used at all three grade levels and was likely to minimise the confounding of interest, achievement, and success-failure experience with performance and expectation better than would a school-related task. The criteria for success and failure were rather ambiguous and motivation for the task was expected and appeared to be high regardless of treatment. This motivational factor coupled with the ambiguous criteria may have mitigated any relationship between E_V and performance that otherwise might exist. School-related measures for which success-failure criteria are unambiguous should be used to further examine the relationship between validity of expectation and performance.

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RESEARCH NOTE

Br. J. educ. Psychol., 48, 227-231, 1978

INTERACTIVE RELATIONSHIPS BETWEEN MEASURED PERSONALITY AND TEACHING STRATEGY VARIABLES

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SUMMARY. Reviews of recent aptitude-treatment interaction research indicate a low level of consistency of results even when considered within a particular age level. It is suggested that an aspect of the problem may be the lack of comparability among the variables commonly employed. Two experiments are described where comparable teaching strategies were employed to teach students of similar ages material from two different subject areas. Comparable disordinal interactions between measured extroversion and teaching strategy were demonstrated across the two experiments where the criterion measure was a test of problem-solving but not where it was a test of recall.

INTRODUCTION

In 1966 Cronbach argued the need for complex experiments exploring the five-fold interaction: subject matter with type of strategy with timing of instruction, with type of pupil, with outcome. A considerable number of investigations have followed and evidence for established relationships between measured personality variables and the style of instruction has been claimed. Leith (1973), for example, argued that there was an established relationship between teaching strategy and the extrovert-introvert dimension of personality. Extroverts achieved higher scores on a criterion measure having followed an unstructured style of teaching while introverts achieved greater success when the presentation of learning materials was more clearly structured. Suchett-Kaye (1972) argued a similar relationship between instructional strategy and the degree of measured anxiety; those students who had a high degree of measured anxiety were more successful with a structured learning programme while less anxious students were successful with less structured teaching. However, these claims do not find universal support. Glaser and Resnick (1972), commenting on reviews by Cronbach and Snow (1969) and Bracht (1970), concluded that the frequency of studies in which disordinal interactions have been found is low and the empirical evidence is often not very convincing in studies that do claim to show such interactions.

A major problem in evaluating the research is the lack of comparability between experiments and between experimental variables. For example, samples have ranged from 8-year-olds in the USA (Grimes and Allinsmith, 1961) through 11-year-olds in Britain (Leith and Bossett, 1967), students in the USA (Maltzman *et al.*, 1956) and Britain (Leith and Wisdom, 1970) to adult sailors in the USA (Tallmadge and Shearer, 1969 and 1971) and civilians in Britain (Leith *et al.*, 1968). Anthony (1973) has argued that extroversion measured by Eysenck inventories demonstrates age-related changes between 7 and 14 years, and there is support for this proposal from Seddon (1977) which suggests that the comparability of some age-differentiated experiments is at least doubtful.

Both the personality measures and the subject matter of instruction have varied widely among the investigators. Tallmadge and Shearer, for example, used the Gordon Stability and Sociability Scale in their 1969 study and the Eysenck Personality Inventory two years later. Grimes and Allinsmith (1961) taught children to read, while Leith and Webb (1968) used meteorology as a teaching subject. Leith *et al.* (1968) used the proposed system of decimal currency for Britain while Trown and Leith (1975) drew upon mathematics.

Despite the original concern of Cronbach (1966) for learning outcomes, a major feature of the lack of comparability amongst the published research is the different criteria used to measure attainment. Richards and Bolton (1971) demonstrated that the criterion test employed must be clearly related to the learning outcomes expected from the treatment applied, yet very few experiments have investigated recall and transfer as separate items. Leith and Trown (1970) made this differentiation, but Leith and Webb (1968) relied on recall, Maltzman *et al.* (1956) relied on problem solving and both Grimes and Allinsmith (1961) and Leith and Wisdom (1970) investigated recall and problem-solving in an undifferentiated manner. Perhaps the most distinctive use of criterion measures was by Tallmadge and Shearer who, when comparing the results of different subject matters (transportation techniques and aircraft recognition, 1969, celestial navigation and aircraft recognition, 1971), used tests of recall for the aircraft recognition programme and tests of problem-solving for the transportation techniques and celestial navigation programmes.

Perhaps the most difficult variable to evaluate is teaching strategy. This generally represents a dichotomy based on degree of structure, but beyond such a general statement it is quite impossible to equate the contrasting treatments across the researches. Grimes and Allinsmith (1961) compared phonic (structured) and look and say (unstructured) methods of teaching. Leith and Bossett (1967) compared organised arrangement + underlying principle given + answer given (structured) with random arrangement (unstructured). Leith and Trown (1970) compared rules before practice (structured) with rules after practice (unstructured).

Two experiments carried out by the present author demonstrate some of the problems raised by differences between the variables of related experiments.

HYPOTHESES AND METHODS

Experiment 1

211 first-year students in a mixed college of education completed an experiment based on 2 × 2 × 2 × 2 × 2 randomised blocks design with teaching strategy as the treatment variable and sex, measured intelligence (AH5), anxiety and extroversion (Hallworth HB) as the organismic variables. The subject content (introductory genetics) was taught by programmed texts (see Appendix). The structured version presented the material systematically and deductively while the unstructured version taught the same material inductively from presented data. The equivalences of the two versions overall was established by a trial. The attainment of students was measured on a 50-point test of problem-solving one week after completing the treatment. Full details of the procedure and the tests used have been given elsewhere (Shadbolt, 1969).

The experiment was designed to investigate the hypothesis that students scoring high on extroversion scales (HiE) would achieve a higher criterion test score having followed an unstructured teaching programme while LoE students would find a structured programme more appropriate to their introvert personalities. Similarly high anxiety (HiA) students would achieve a better test score having followed a structured programme which would offer them less stress than an unstructured programme.

Experiment 2

145 first-year students at another mixed college of education completed an experiment based on a 2 × 2 × 2 × 2 × 2 randomised blocks design with structured and unstructured teaching strategies as the treatment variable and measured intelligence (AH5), neuroticism and extroversion (Eysenck Personality Inventory Form A) and arts-science orientation (Joyce and Hudson) as the organismic variables. The subject content (history of education) was taught by programmed texts produced in two forms comparable to those of Experiment 1. The equivalence of the two forms was established in a trial. The attainment of students was measured by a 40-point test of which 20 points were allocated to a test of retention (Part I) and 20 points to a test of problem-solving (Part II).

The hypotheses relating personality to teaching strategy were as for Experiment 1. It was considered that the teaching provided by the structured strategy might favour results on a test of recall while the unstructured strategy might favour the learning of problem-solving, although these hypotheses were considered tentative as earlier evidence was conflicting. Leith and Trown (1970) found no interaction between strategy and learning outcome while Worthen (1968), also working in mathematics, found that unstructured teaching favoured retention and transfer while structured teaching favoured recall. In contrast Rowell *et al.* (1969) suggested that structured teaching favoured recall, retention and transfer.

RESULTS

In both experiments the criterion test scores were subject to an analysis of variance for unequal numbers in cells (Walker and Lev, 1953).

Experiment 1

There were three significant main effects: those scoring high on AH5(HiI) scored significantly better ($P < 0{\cdot}01$) than LoI students; women scored significantly better than men ($P < 0{\cdot}05$); LoA > HiA ($P < 0{\cdot}05$).

There was one significant interaction: a first order interaction between teaching strategy and extroversion, $P < 0{\cdot}05$ (see Table 1)—a disordinal interaction according to the criteria of Lindquist (1953) and Lubin (1961), but not according to the stricter ruling of Bracht (1970). The first order interaction between teaching strategy and anxiety was not significant.

TABLE 1

EXPERIMENT 1—MEAN POST-TEST SCORES OF FIRST ORDER INTERACTIONS BETWEEN TEACHING STRATEGY AND MEASURED EXTROVERSION AND ANXIETY (RAW SCORES)

	Structured	Unstructured	P
HiE	21·36	24·28	·05
LoE	24·67	21·03	
HiA	20·91	21·51	NS
LoA	25·12	23·80	

Experiment 2

Measured intelligence was the only significant main effect:

Part I HiI > LoI ($P < 0{\cdot}05$), Part II HiI > LoI ($P < 0{\cdot}01$)

The only significant interaction between teaching strategy and a measured personality factor was that between treatment and neuroticism on the test of recall ($P < 0{\cdot}05$) (see Table 2). The interaction is disordinal according to the criteria of Lindquist and Lubin, but not Bracht.

TABLE 2

EXPERIMENT 2—MEAN POST-TEST SUMS OF FIRST ORDER INTERACTION BETWEEN TEACHING STRATEGY AND MEASURED EXTROVERSION AND NEUROTICISM (STANDARDISED SCORES $\bar{X} = 50$, $\sigma = 10$)

	Part I			Part II		
	Structured	Unstructured	P	Structured	Unstructured	P
HiE	52·42	51·04	NS	49·67	50·97	NS
LoE	49·00	47·49		50·53	48·80	
HiN	52·08	46·58	·05	51·95	50·89	NS
LoN	49·35	52·03		50·00	48·61	

DISCUSSION AND CONCLUSION

The significant first order interaction of extroversion and teaching strategy on a test of problem-solving in Experiment 1 and the significant first order interaction of neuroticism with teaching strategy on a test of recall in Experiment 2 both support the informal hypothesis that HiE students achieve a higher attainment score having been taught by unstructured methods and HiN students achieve a higher attainment score having been taught by structured methods.

However neither interaction was disordinal according to the strict criteria of Bracht (1970) and although there was consistency between the form of the interaction of extroversion with strategy on tests of problem-solving between Experiments 1 and 2, no such consistency was demonstrated for the relationship between neuroticism and teaching strategy on tests of problem solving.

The higher order interactions of extroversion and neuroticism/anxiety with teaching strategy were not significant and gave no indication that a particular cluster of personality characteristics was successful, although Entwistle and Brennan (1971), taking a wider spectrum of characteristics, have argued that clusters of personality characteristics provide a more fruitful basis for the analysis of data where complex interactions occur.

One feature that was clearly demonstrated by Experiment 2 was that creating a global test score by a combination of a variety of criterion measures is an unsatisfactory procedure. Analysis of variance of the total post-test score (by adding Parts I and II) revealed that the first order interactions of Parts I and II were lost and the forms of the interactions between personality measures and teaching strategy were varied.

Teaching for individual differences implies two complementary processes: capitalising on the existing aptitude pattern for short-term gains and varying teaching strategy to develop independence and adaptability in the long term. The present state of empirical evidence does not provide a sound basis for developing an adequate programme leading to successful aptitude-treatment interactions. Clarification of the nature and form of the critical personality variables (or clusters of variables) is needed; treatments require careful definition in operational terms and the measures of learning outcomes must be clearly specified and clearly discriminated.

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APPENDIX: THE LEARNING MATERIALS

The learning materials were presented to students as programmed texts in the form of duplicated booklets composed of stapled pages (21 × 15 cms.). Each frame of the programme was provided on a double page when the booklet was opened. The text was presented in the right-hand page while the left-hand page was left blank for student's response or rough work. The recording of answers to questions and rough work was optional.

The structured and unstructured forms in each experiment covered the same subject content in much the same number of frames. Generally the structured programmes built up the information step by step, presenting the facts and terms and confirming these by problems based on further illustrations or logical inferences. In contrast the unstructured frames made an initial presentation of the complex material (i.e. as established at the end of the structured programme) and by a series of questions guided students to discover the facts and terms within the complex.

CORRIGENDA TO ARTICLE BY KEMPA AND McGOUGH

A Study of Attitudes Towards Mathematics in Relation to Selected Student Characteristics—November 1977 issue, 296-304.

1. Tables 3 and 5 should be as shown below:

TABLE 3—CORRECTED VERSION

MEAN SCORES ON ATTITUDE SCALES FOR DIFFERENT ACHIEVEMENT LEVELS IN ' O ' LEVEL MATHEMATICS

Attitude Variable		Total Sample (N=199)	' O ' Level Grades					F-Ratio P<
			1,2 (N=31)	3 (N=62)	4 (N=36)	5,6 (N=38)	7,8,9 (N=32)	
Difficulty/Ease of Learning Mathematics	Mean	23·53	25·10	24·31	23·67	23·37	20·56	3·31
	SD	5·60	5·30	5·06	4·47	5·93	6·75	(0·02)
Importance/Usefulness of Mathematics	Mean	13·32	15·16	13·23	12·36	13·68	12·34	3·14
	SD	3·81	4·04	3·97	2·78	3·69	3·88	(0·02)
Enjoyment/Liking of Mathematics	Mean	39·84	49·16	44·53	37·08	36·34	29·00	23·17
	SD	11·56	9·08	9·24	8·82	10·98	9·91	(0·001)
General Liking of School Learning	Mean	30·03	30·94	31·26	28·89	28·11	30·34	1·93
	SD	6·39	6·23	5·43	7·26	6·05	7·20	(NS)

TABLE 5—CORRECTED VERSION

MEAN SCORES ON COGNITIVE PREFERENCE SCALES FOR DIFFERENT ACHIEVEMENT LEVELS IN ' O ' LEVEL MATHEMATICS

Cognitive Preference Variable		Total Sample (N=199)	' O ' Level Grades					F-Ratio P<
			1,2 (N=31)	3 (N=62)	4 (N=36)	5,6 (N=38)	7,8,9 (N=32)	
Graphical/Diagrammatic Mode	Mean	26·63	26·29	26·27	26·11	27·74	26·94	0·55
	SD	5·67	5·83	5·61	5·39	5·95	5·73	(NS)
Symbolic Mode	Mean	53·60	56·16	54·10	55·08	51·95	50·47	5·88
	SD	5·78	4·02	5·28	4·12	7·25	6·15	(0·001)
Verbal Mode	Mean	39·76	37·55	39·63	38·81	40·32	42·59	3·28
	SD	6·02	3·91	5·32	6·06	7·44	6·23	(0·02)

2. The diagram used in the study was labelled X, P, S, R, Q rather than A, B, C, D, E, as shown on page 298 of the article.
3. The reliability of the sub-scale (ii) of the attitude inventory should be 0·61, and not as printed.
4. In the tables above, former GCE grades 1-6 correspond to new grades A-C and the former 'failing' grades 7-9 correspond to new grades D, E and unclassified.

BOOK REVIEWS

BADDELEY, A. D. (1976). *The Psychology of Memory.* London: Harper and Row, pp. xvii + 430, p. £4·95, c. £9·75.

It is frustrating that often the leading figures in certain areas of psychology are far from being the clearest when it comes to putting their ideas onto paper. It comes as a pleasure, therefore, to encounter such a well organised and readable book as *The Psychology of Memory* written, as it is, by one of the most prominent researchers into memory over the last ten years. The style is clear, often containing a welcome sense of humour and Dr. Baddeley is at pains not to overcomplicate and to provide easy reference back to earlier arguments in the book. As such *The Psychology of Memory* would work excellently as an undergraduate textbook and provides an ideal introduction to the type of problems and areas of research currently under investigation.

A wide range of research is reviewed from the ' Nonsense Syllables ' of Ebbinghaus and the ' Linguistic Relativity ' of Whorf to the ' Generative Grammar ' of Chomsky and the Computer Programme of Winograd. Areas of traditional interest such as Interference Theory and the Long Term Memory—Short Term Memory distinction are reviewed as well as more recently fashionable topics such as Semantic Memory, Memory for Prose and Mnemonics. The ignored area of Sensory Memory is also reviewed as is work on clinical cases. Although a chapter on Children's Memory would have been informative, the book is well balanced. Very recent work in some areas is missing but this is unavoidable when writing a book of this scope with new material appearing almost daily.

We are not altogether happy, however, with the way in which certain areas of current debate and controversy are dealt with. Dr. Baddeley justifiably scorns giving a purely objective and descriptive presentation of his subject but at times his conclusions are questionable. Craik and Lockhart's ' Levels of Processing ' approach receives a somewhat niggardly put-down. This consists of some equivocal evidence from neuropsychology; the view that depth of processing may be confounded with other factors such as total time of processing; and that there is no evidence for deeper levels of processing within the semantic domain. Dr. Baddeley also complains of a circularity of definition in levels of processing and that the theory as a whole adds little to the standard dichotomous view for so long defended by him. However Craik and Tulving (1975) have shown differences in semantic processing due to the orienting task and both that paper and Hyde and Jenkins (1973) appear to have ruled out processing time as a critical factor. The point about circularity is more serious, but has this circularity made for uninteresting and obvious *post hoc* explanations? Has it led to doubt among researchers as to what they are talking about? One could argue that a clear definition is a goal of research rather than an *a priori* necessity. This is not to say that Dr. Baddeley's criticisms are completely unfounded. They do not, though, seem sufficiently compelling to ignore a theory which has been exceptionally fruitful in stimulating new research, the results of which we await to hear as adequately explained by the standard dichotomous view.

The review of imagery unaccountably does not mention Pylyshyn's (1973) seminal paper on propositional representation; and the abstract alternative to Paivio's separate visual/verbal system only appears undeveloped at the end of the chapter. Pylyshyn's arguments against the logic of long term storage of raw pictorial information could have been profitably discussed when evaluating the status of long term visual memory.

In common with many others, Baddeley is critical of Endel Tulving's ' Encoding Specificity Principle ' and his distinction between Episodic and Semantic memory. Episodic memory refers to one's store of experience and semantic memory to one's knowledge of the world which enables language to be comprehended. Dr. Baddeley writes (p. 318), "... it remains very doubtful whether this reflects a clear dichotomy between separate storage systems, as Tulving suggests ". The reason why Tulving postulated this distinction was that on the basis of this, Light and Carter-Sobell's (1970) and other work on context changing it was no longer possible to conceive of memory traces as ' tagged nodes ' between items. So, Tulving argued, it seems more parsimonious for each stored experience to exist discretely in an ' Episodic Memory ' distinct from our semantic knowledge. The strange thing is that Dr. Baddeley himself, despite the criticisms cited above, comes to a similar conclusion to that of Tulving. He does not adhere to the Reder *et al.* (1974) reformulation of the ' node tagging theory '. Rather Dr. Baddeley states (p. 298) "... the subject encodes the information to be remembered in some area of ' semantic space ', not in some specific location representing the dictionary definitions of the words in the sequence ". It seems to be a case of slightly changed terminology revealing the same underlying theory.

It must be stressed that Dr. Baddeley's arguments are generally coherent and fair and he concedes in the Introduction that no-one will agree with everything he says. Indeed it may be to the credit of a textbook that it directly stimulates debate and discussion. As a textbook, then, *The Psychology of Memory* is pre-eminent, being so comprehensive in the area it covers and so well written. The extent to which it will influence future research is however a matter of opinion.

MAUREEN AND J. R. HANLEY.

BANNISTER, D. (Ed.) (1977). *New Perspectives in Personal Construct Theory*. London: Academic Press, pp. 355, £10·80.

FRANSELLA, F., and BANNISTER, D. (1977). *A Manual for Repertory Grid Technique*. London: Academic Press, pp. 193, p. £3·80, c. £7·50.

SLATER, P. (Ed.) (1977). *The Measurement of Intrapersonal Space by Grid Technique—Vol. 2: Dimensions of Intrapersonal Space*. London: Wiley, pp. 270, £12·00.

These three texts, all published within about six months of each other, appear to have a certain amount in common but are widely different in scope and interest to educators. The first two are both, in their different ways, espousals of the methods of Personal Construct Theory (PCT) whilst the third is an attempt at theoretical advancement within PCT.

Slater's book is notionally an edited text but is written mostly by Slater himself, with only three chapters by other contributors. It is the companion volume to *Explorations of Intrapersonal Space* and gives details of the method whose applications are suggested in that first volume. Whilst it seems daft to give the applications of a method before it is given in detail, it is clear that this is a rather subtle sales technique since, if logic had prevailed, no-one would have felt inclined to buy the second volume if this one, describing the method, had been the first. It rambles inconsequentially in many places, with diatribe and insinuation against Kelly, former colleagues, research institutions and others who had reservations about Slater's technique. Whilst the writer is able to convey enthusiasm for his own methods, this is often at the expense of clarity and theoretical development. The fact that others have seen applications for the method seems to take Slater with mild surprise. By maintaining a rigorous restriction of Kelly's views to the original (1955) statement of position, and being rather unheedful of the ways in which subsequent workers have developed, explicated and expanded the theory, Slater is able to divorce his work almost entirely from Kelly's theoretical views. The attempt to reduce all analytic techniques (e.g. Semantic Differential, Repgrid, Q Techniques) to the same one misses out much of the theoretical distinction between different approaches and leaves one with the uncomfortable feeling in the final chapter that his is essentially an atheoretical stance which relies on mathematical expedience and technical frippery as its guiding lights.

Whilst Slater's work labours to divorce method from its theoretical provenance, Fransella & Bannister on the other hand take great pains not to present a mere workshop manual and emphasise the essentially theoretical nature of their listing of grid developments. Every reader ought to read and reread the first few pages before proceeding to the developments of ' Repgriddary ' that are presented, but the original theoretical stance is well maintained. In this work the full theoretical assumptions of grid methodology in general and each grid method in particular are outlined and discussed in such a way that one gets a good feel for the theory as a developing approach with exciting potential. Whilst Slater gets bogged down in preaching to the converted, this text stimulates, extends and invites. Those professionally concerned with education or psychology will find several useful chapters on techniques that can be profitably used in their fields and students will find this volume stimulating and unpatronising. The book contains a set of appendices, wherein several different papers using grid methods are listed in summary and briefly commented on. There is also a bibliography of books employing Repgrid techniques and a glossary of terms. In short, this is an excellent manual, bibliography and source book which never falls into the obvious trap of becoming a boring list of applications of a single technique but is an interesting and essentially theoretical discussion of the various methods that can be employed to use PCT in many fields of enquiry.

Bannister's edited text is, in essence, a second version of the 1970 volume *Perspectives in PCT* using different contributors who represent the second generation of PCT workers and are also from a wider range of countries than those in the earlier volume. Again, however, the authors were instructed merely to choose a theme and write on it from a PCT vantage point and the reader is left to himself to judge the strength of the individual approaches and the general theory that promoted them. The volume thus contains a wide range of ideas, from those chapters where PCT and its methods were applied to some pre-existing problem to those which attempt to develop and expand PCT itself. There are in such a volume the usual number of things that characterise the authors as Kellians and the usual number of views or characteristics that will infuriate the unbeliever (and it does feel like a religion at times) whilst exhilarating the hardened practitioner. There is, for example, a larding of penitential self flagellation about " how I failed the theory " or " why I failed to grow ", the usual doses of irreverence, gimcrack and false jocularity—but on the whole these are in the rather self-conscious chapters by the newer members to the ranks. There are excellent chapters by Bannister (on emotion), by Mair (on the structure and concept of self), by O'Reilly (on children's and adults' construing) and by Ravenette (on dealing with disturbed children and adolescents). There is a poor chapter on emotions, a dreadful, trendy chapter supposedly about science, with poor grammar and few incisive ideas; and one that contains the memorable sentence (p. 73), " A vision and a 35 ft fall from a tree house . . . brought him to the realisation that he did not need drugs to attain spiritual consciousness ".

In short this book is rather a mixed bag, in which the average level of contribution is probably a bit below that of the earlier volume, although there are enough good or excellent chapters to ensure that it will be useful in the library. It is a bit discouraging, however, that this type of judgment is prompted by a volume where the second generation, the new banner carriers, are being paraded.

In conclusion, two of these three books contain enough stimulation for educational psychologists to be prompted to buy or use with students. Paradoxically, however, the best value for money in both practical and theoretical terms is the Fransella and Bannister manual. Whilst providing many examples of techniques that will be useful to educational psychologists it also manages to stimulate one's theoretical palate.

STEVE DUCK.

BARNES, D., and TODD, F. (1977). *Communication and Learning in Small Groups.* London: Routledge and Kegan Paul, pp. 139, £2·50.

This volume presents a study of and further theoretical discussions about the nature of children's talk and its possible roles in school learning. The study and discussions are based on transcripts of the tape-recorded talk of 13-year-olds of average ability. These pupils were withdrawn from their classrooms for short periods of time without their teachers and asked to work in groups on practical problems and on the discussion of various topics. Their teachers collaborated in the provision of the group tasks on which the children would work during the tape-recorded sessions. In all, 56 pupils participated in making the recordings and study is based upon 11 hours of such recordings.

Barnes and Todd report with unusual honesty and clarity the procedural difficulties they encountered. For example, their first set of data came from two schools but in the second phase they were in only one school because it was there that they found teachers " willing to make time to work with us ". The untidy nature of samples which must rely on the willing collaboration of teachers and children in school is well described, along with the procedural set-backs and analytical perplexities which currently burden educational field researchers. Some of the tedium involved in transcribing sound tapes is also commented upon, making it possible for the teacher/reader or the new researcher to make a realistic appraisal of what is involved in the choice of school-based research procedures. Compared with their original intentions, Barnes and Todd report some losses in their study. Their intention to compare children's talk in ' Assess ' and ' Non-Assess ' conditions, the ' Assess ' condition involving the children's belief that their teachers would assess performance, had to be abandoned. As well, the intention to categorise the children's talk in an ' objective ' manner was seen as spurious and dropped. Instead, the authors concentrate on devising a new and more acceptable way to analyse the transcripts they have, drawing from their analysis a description of the features of their pupils' talk, generating advice to teachers and others wanting to add to their understandings of task-related talk, and giving comment on the usefulness of expecting young learners to use their own and each other's talking as a means of learning.

The authors give examples to show that adolescents of average intelligence can successfully carry out collaborative learning in small groups. From the research experience and the subsequent theoretical analyses they offer helpful and defensible suggestions to teachers who wish to help such learning to come about. On a more theoretical level, the authors advance a proposal that conversations might be understood as a series of frames, each frame containing the participants' views of what substantive content and which interpersonal relationships are being negotiated at that point in the discussion. In reporting so fully and helpfully their analytical problems and solutions the authors add to our appreciation that, for all who would listen to learners talking, the search is not so much for descriptive systems as for systems that make sense.

M. Cameron-Jones.

Bloom, B. S. (1976). *Human Characteristics and School Learning.* New York: McGraw-Hill, pp. xii + 284, £8·20.

The aim of the book is to support the view that when students learn under conditions that are favourable there are only small differences between them in learning ability and performance. In the first chapter Bloom lays out his fundamental thesis that individual differences in learning performance are the product of the student's learning history and the quality of instruction he receives. He argues that when learning conditions are ideal, individual differences should be negligible. The next section deals with the problem of defining a learning unit suitable for the study of school learning. Such a unit is seen as having the need to be based on what is typically found in the practical school situation, and consequently should be applicable to both group and individual learning, should be subject centred and teacher directed. He concludes that such a unit should be a learning task such as a chapter from a textbook or a topic in a course. Learning outcomes of the unit are considered to be influenced by the student characteristics of (in Bloom's terms) cognitive entry behaviours, affective entry behaviours and the quality of the instruction.

In the remainder of the book he seeks to demonstrate that not only does each of these variables affect learning performance but modification of each is possible to improve learning. Chapter Three considers the cognitive entry behaviours. By this term he means " the prerequisite learning needed for a particular learning task ". He shows that learning performance is dependent on prerequisite learning by reporting that achievement at a school grade in a subject such as mathematics, English or science correlates highly with performance on the one that preceded it. On specific learning tasks, he notes that the achievement on a task followed by correction to mastery correlates with achievement on the next task less highly than with a condition of non-mastery. The fourth chapter considers affective entry behaviours and cognitive learning performance. Bloom uses this term to denote ' a complex compound of interests, attitudes and self-views ' (p. 75). He reviews studies of the relationship between affective measures and learning and shows that the correlation between them is typically of the order of 0·4. The next chapter looks at the effect of the quality of instruction on learning performance. The quality of instruction is assessed in terms of four elements: " cues or directions provided to the learner, participation of the learner, . . . the reinforcement which the learner secures, . . . and feedback/correctives " (p. 115). Bloom concludes that the quality of instruction accounts for around 20 per cent of the variation in learning performance. The final three chapters consider the affective outcomes of school learning, the interaction between the entry behaviours and the quality of instruction, and the implications of the studies.

While this book contains a useful survey of studies of school learning, it appears to have two weaknesses. To begin with, as a psychological study of school performance, it is too general to be practically useful. Fundamentally Bloom is saying that for successful learning pupils need to understand the concepts on which the new learning is to be based, be interested in studying the topic and be effectively taught. All this is true, and educators need to be mindful of the importance of meeting the three conditions. However, to the experienced teacher these will appear to be rather obvious conclusions. The studies reported are general and give no guidance in deciding the order in which subject matter should be taught, or of how interest can be cultivated, or of specific ways of improving the quality of instruction.

Secondly, the book fails to make any mention of the effect of personality and cognitive style variables on learning performance. Surely the term ' Human Characteristics ', which occurs in the title, includes not only individual differences in current knowledge and attitude but also personality and learning style. In a study on the improvement of learning the omission of any discussion of variation in learning style suggests that the author thinks style differences are unimportant or that they should be discouraged. Either way, in view of the findings of studies of the effect of style on learning and on the way in which students prefer to organise and present information, he needs to justify his opinion.

R. J. RIDING.

CATTELL, R. D., and KLINE, P. (1977). *The Scientific Analysis of Personality and Motivation.* London: Academic Press, pp. v + 385, £11·50.

This book is essentially a rewrite of Cattell's Pelican on *Scientific Analysis of Personality* and claims to have been more closely adapted to student use but also updated in relation to intervening advances. " Its basic aims are to explicate the results of the multivariate analysis of personality and to integrate Cattell's work with non-multivariate psychological theory." The book also deals with the work of other theorists (Guilford, Eysenck, Comrey) although not in very great detail. As might have been expected, the methodological and substantive advances made by Cattell are clearly described, and anyone who is interested in factor analytic work in this field will find this book a great help in introducing the subject. The book seems much clearer than the original on which it is based; it is also somewhat less technical.

The major criticism of the book would be that it is very selective in its coverage. There is little discussion of criticisms, for instance, that factor analysis by its very nature must proceed in a circle unless it can break out of that circle and link up with properly testable causal theories relating its concepts to physiological and psychological theory. One such attempt to break out of the factor analytic circle has been to link the concept of introversion with that of cortical arousal; there is no mention of arousal in the book. This illustrates a general weakness in the book of disregarding concepts and studies relevant to Cattell's theory, but extraneous to his own group. This is a pity; the book could have been really outstanding had the sympathy of the authors extended a little further than the narrow confines of the present tome. Within those confines the book makes a genuine contribution to the teaching of students of psychology; many students may, however, feel too confined by these limitations to appreciate the very real advances that Cattell has made in the study of personality.

H. J. EYSENCK.

ENTWISTLE, N. T., and WILSON, J. D. (1977). *Degrees of Excellence: The Academic Achievement Game.* London: Hodder and Stoughton, pp. ix + 226, £7·95.

Noel Entwistle and John Wilson's book represents another brave attempt to explain differences in the academic performance of students, in this case in Aberdeen and in seven other universities (the Rowntree project), by multivariate analyses. It is a well-thought-out report, and includes a concise overview of research on student success and failure in the first part, a description of the research projects in the second and third parts and a skilfully assembled synthesis and conclusions in the final part. The two middle sections give a very clear account of research exercises and elegant analyses. The synthesis and conclusions of the two studies end up with a valuable chapter on implications for action.

Although the two studies are different in method of sampling, in measuring instruments and in the methods of analyses, the overlaps of findings and conclusions are more than incidental and the use of the same personality test serves well as a common moderating factor. The authors link two studies in an attempt at prediction, and their ' Academic Achievement Game '—whatever its shortcomings—is a useful source of discussions for courses on ' study methods ' for students, and for courses on ' how to teach ' for academic teachers. It is a neat, didactic tool and I would certainly use it, if only to bring in a model of rational analysis of the contingencies which might affect students' passage through universities. I would also recommend, as a point for study and discussion, the neat picture of the ' circular representation of the main finding characteristics within four subject areas ' of high, average and low achievers derived from cluster analysis of the Rowntree Survey. However simplistic such a chart may appear, it does reflect the more ' common-sense ' expectations and coincides with other psychological findings. The emotional instability sector neighbours, as expected, many of the compensatory sets of reactions to anxiety and over-sensitivity: poor study methods, low motivation, radicalism, syllabus-free preference, high aesthetic and social values; whilst the emotional stability sector adjoins the opposite styles of values and behaviour. The pattern of the ' high ' and ' low ' attainment clusters shows a general tendency towards introversion and stability for the former, and extraversion and emotional instability for the latter.

To a researcher in the same area the book is of interest and value throughout. To general readers I would, however, recommend the synthesis and conclusions, starting, if possible, with the last chapter on implications for action. It is here that the authors' insights, pedagogical and psychological knowledge and familiarity with problems of higher education in the UK are fully and usefully deployed. They show that, whatever the merits or demerits of educational and psychological studies of factors related to the wastage of students, such researches always raise pertinent questions of what is happening and what is likely to happen in higher education when the individual differences of students and teachers are disregarded in the strategies of tuition and learning. Since teaching-and-learning, particularly that which becomes locked in formal curricular requirements, is always a social transaction and, as such, a relationship, the way this relationship develops and how the transactions are played must surely depend on the kind of people who meet in this process; their aspirations, hopes and fears about the outcomes of their respective actions must remain paramount. This relationship is seldom, if ever, properly explored in studies of factors affecting degrees of academic excellence. It is usually the students' side of the picture that is studied and, as such, it is bound to produce highly unsatisfactory outcomes. Yet even such studies suggest that there may be some aspects of temperamental dispositions which enable some students to adapt advantageously to the tuition milieu, whatever the contingencies of the teaching side. To this extent, the Aberdeen and the Rowntree studies, like other similar ones, have their value. They often show that the proportions of the adaptable people are relatively small in total populations and suggest that the skills of ' educational tractability ', so essential to academic excellence, could, like most things in life, be taught and learnt, possibly by training students to become more independent learners.

Discussing problems of selection and wastage the authors are inclined to recommend innovations in tuition. Writing about difficulties of transition from school to university they say: " One possible remedy, both to inaccurate selection and to some of the causes of student failure, would thus involve matching teaching methods across this educational watershed ".

Then there are always the important fragments of such researches, as for instance the fact that, in the Aberdeen study, no less than 45 per cent of the students in the first year fell into the ' at risk ' category and 47 per cent were ' at risk ' in the final degree analysis; or that, from the 1967 cohort, no less than 18 per cent did not obtain degrees, plus 2 per cent of voluntary withdrawal, etc., amounting to nearly 1 in 5 students wasted! If students are regarded as a vital part of the nation's investment, this wastage represents, at the current prices, a loss to the state of some £895,968, and should be a matter of real concern. It can also be estimated that the loss of fees, directly to university coffers, now at £542·50 p.a. per student—a sum of £1,627·50 if a student sustains a three-year course—is very considerable, standing at £332,010 (at 1977 prices) for the 204 students of the Aberdeen 1967 cohort who left without a degree! And Aberdeen losses are not untypical in universities and polytechnics, particularly when careful monitoring of departmental losses is carried out by the 'cohort' method. Research into problems of academic achievement has long ceased to be a matter of purely academic interest and, like many other surveys in this area, Entwistle and Wilson's work has a hard-fact pragmatic value.

But there is also another 'spin-off' finding which the book, corroborating other surveys, makes explicit: the successful, high achievers generally, but particularly in the 'hard sciences', tend to be *toughminded, introverted and conservative.* Their disposition may be one which enables them 'to persist in their objectives, whilst appearing to give way to others' (Kant) or, as in Einstein's equation for success, quoted by the authors, one which makes for a capacity for 'work, play and for keeping your mouth shut'—very neat formulae for success in any milieu! But can such a disposition be readily made open to educational innovations? Innovations and development may need somewhat different dispositions which may, at present, be subject to attrition. The findings of the Aberdeen and Rowntree studies hint at this and they deserve to be read not only by students of psychology, but also by all those concerned with educational renewal. The mechanisms for change and integration—including their extreme aberrations—as encapsulated in personalities of the personnel, might become key factors to understanding many of the social dynamics in many institutions.

J. A. WANKOWSKI.

GEBER, BERYL A. (Ed.) (1977). *Piaget and Knowing: Studies in Genetic Epistemology.* London: Routledge and Kegan Paul, pp. 258, £5·75.

This book is derived from a series of seminars held in the Psychology Department of the London School of Economics. The stated aim is " to focus on synthesis through examination of the relevance of the theories of Jean Piaget to particular research areas in psychology ". It would be less misleading, in my opinion, to state the aim the other way round. This is much more an exercise in fitting some disparate areas of research to particular areas of Piaget's monumental theory.

There is an excellent digest of Piaget's theory of knowledge and a clear statement of the problems the later papers should consider in Geber's introduction. Unfortunately, this clarity is immediately dispelled in the first paper by Roger Holmes. He sets out to describe the nature of the conflict between experimental psychologists and psycho-analysts and to show how an acceptance of Piaget's approach could modify such conflict. Except for the rather trivial observation that, if all psychologists were to adopt a Piagetian approach, all major conflicts within developmental psychology would disappear, this aim seems to require little further comment. Holmes takes 48 pages to comment further. At the end of it, he claims " The psychoanalyst . . . can provide an admirable corrective to our presumptions of personal impotence ". I think this is one of a number of misprints. I think he means the final word to be 'omnipotence'. The sad thing is that it doesn't really seem to matter.

The delivery of this paper might have mesmerised a compliant audience. It is unlikely to impress favourably a reading public. Statements like " Structuralist knowledge . . . may be able to swallow its own tail and then suspend itself in mid-air—but only after someone has put it there " might intrigue a latter day Tenniel; I doubt if they do anything to further the sales of psychology texts.

It will be unfortunate if many potential readers are alienated by this first paper since the rest of the book is worth reading. It contains a range of interesting contributions from a wide variety of contributors. Bryant is there, elegantly tilting away at the straw man he has created from Piaget's theories. Can he really believe that Piaget thinks that children cannot under any conditions " link relational judgments in an inference until they reach the age of roughly seven or eight years "? Furth highlights the flaws in Bryant's reasoning in a discussion of the operative and figurative aspects of knowledge in Piaget's theory. Unfortunately, the brilliance of the exposition of this theoretical perspective is not matched in the description of Furth's own recent work. Skimped detail makes it difficult to evaluate. Lunzer adopts the opposite approach, describing fully a number of experiments made to clarify the relation between ' operative ' behaviour, linguistic competence and memory, and to study the predictive power of operativity and linguistic measures on early achievement in reading and mathematics.

Wason presents evidence from his series of ' 4-card problems ' that reasoning at the formal operations stage may be radically affected by the content of the problem. Unlike Bryant, however, he is willing to see that his work poses little threat to Piaget's theory if the latter is construed as a theory of competence rather than performance. In a fairly long article, Hotopf attacks Piaget at his generally-recognised weakest point, on his theory of perception. These criticisms may not be new but are none the less cogent for that.

The paper by Szagun on the development of tense forms in young children includes an examination of the role of cognition in language acquisition and use. It concludes, rather flatly, that there is an interdependence between form and meaning: " Cognition precedes grammar, but grammar also precedes cognition ". The final paper, by Geber, is an attempt to relate developmental psychology to social psychology through an examination of the child's cognitions and relations with others. Geber's style is somewhat extravagant, redolent of the style of the opening paper, but her main point is clear. The critical concepts are those of decentration and the loss of egocentricity. These, it appears, evolve simultaneously.

In essence, much of the book is worthwhile reading. All the contributions are related in some way to Piaget's ideas. That, however, is as far as the idea of synthesis can be pushed.

C. K. MACKAY.

HAMILTON, D. (1977). *In Search of Structure: A Case-Study of a New Scottish Open-Plan Primary School.* London: Hodder and Stoughton for S.C.R.E., pp. vi + 110, £3·50.

The connections between teaching, curriculum and school design are intriguing. Little is understood about the processes by which teachers and their pupils come to terms with buildings and spaces, or of how teaching can and does differ from one type of school design to another. It would be valuable to know more about such matters in order to offer more systematic help to teachers who find themselves working in unfamiliar settings, for the opportunities and constraints may not be self-evident, nor may changed demands upon teaching skills be met easily. There are other reasons too for conducting studies of school designs, many of them bound up with the more general responses of individuals to novel situations. Much may be learned about how decisions are reached and how and with what consequences individuals adapt to places. School design has, then, wide psychological as well as pedagogical interest.

In *Search of Structure* is based on a study of the planning and operation of an open-plan unit for young pupils in a primary/secondary school in Scotland. It deals with one of the major developments in school design in recent years; one that is perhaps particularly controversial because it not only represents important shifts in design but also symbolises for many people major changes in thinking about and practising teaching. Dr. Hamilton was given wide facilities over several months to collect information on the background to the new unit and to interview and observe teachers at work. His report is presented as a collection of essays, some providing historical background to changes in school design, an introduction to his methods of study, and an examination of the decisions behind the choice and construction of the unit; while others examine selected features of the actions of the teachers and children. Dr. Hamilton suggests that the essays may be read in any order; however, the theme of 'structure' which is intended to hold the essays together hardly serves to do so and they are perhaps best read in their order of presentation. The essays are generally lucid and written in a non-technical manner, and those characteristics coupled to the general interest of the theme should make the book attractive to a wide readership.

Given these merits it is a pity to have to say that *In Search of Structure* is in several other respects a disappointing work—and the more so because Dr. Hamilton is an able researcher and writer and was given considerable support by the school itself to carry out his investigations. The difficulty is to identify what went wrong with the study, and produced a book which is ill-assorted in presentation, superficial in its treatment of the working lives of the pupils and teachers and even downright silly at times in what is said about research and researchers.

It is possible that some of the failings stem from the choice of an essay format since this would both fragment any general theme and restrict any developing analysis of the open-plan unit. Also, the temptation provided by essays to try to combine general commentary on educational ideas and practices with treatment of a case study worked against the satisfaction of both purposes. Indeed, if the historical essay had been omitted on grounds of generality and the opening one similarly expunged because it was largely unnecessary then the space made available might have been used with some advantage to the case study. However, I suspect that the major causes of the weaknesses of the book can be found in the methodology of the case study. It is not clear that Dr. Hamilton knew where he was going in doing the study, nor, supposing that he wanted teachers and pupils to take him there, that he employed his skills effectively in bringing out the constructs of those he was interviewing and observing.

It has become fashionable for ethnographic writers to decry the supposedly rigid and pre-emptive strategies of more traditional researchers, offering instead the appearances of openness, flexibility and participant interpretation. In doing so they have failed to recognise that what is often made explicit in method by others remains implicit yet no less constraining upon themselves, and that their method requires particular rigour if it is to avoid producing trivialities. Dr. Hamilton's book fails in my view to provide a dynamic interpretation of the development of the unit and to create a constructive analysis of the actions of teachers and pupils. It lacks adequate explanation of the assumptions underlying his procedures or of the bases on which topics are singled out for treatment in the essays. And, it lacks the kind of information on his interviews and observations that would make it possible for others to examine his interpretations or provide their own.

No doubt readers will come to this book with various purposes in mind: some, perhaps, seeking guidance and reassurance on adjusting their own teaching to open-plan areas, others looking for ways of helping teachers to participate in policy making, others looking for evidence that there are connections between teaching methods and spaces for learning, and yet others wanting a better understanding of teachers' constructions of classroom reality. I suspect that they will all enjoy what they read but essentially take little away with them.

If this review seems particularly critical it is because many researchers have looked to ethnography and illuminative evaluation for a range of qualities that seemed to be lacking in the past from other forms of inquiry. Yet repeatedly I am struck by the discrepancy between the promise and the realisation. What Dr. Hamilton tried to do was very difficult. In the event it called for rather more clarity of approach, rigour in practice, openness about assumptions, and structure to commentary and interpretation than his chosen method provided.

A. MORRISON.

HOM, H. L., and ROBINSON, P. A. (Eds.) (1977). *Psychological Processes in Early Education.* London: Academic Press, pp. xvii + 334, £12·50.

This volume contains eleven chapters each written by an authority in child development or education. The chapters are arranged in three sections. The first considers the relationship between child psychology and early childhood education. Since one of the aims of the book is, ' to extend relevant psychological theory and research into early childhood education ', the two chapters in this section might be expected to contain the substantial theoretical foundation on which subsequent authors build their views. In chapter one Donald Peters describes an interesting, formal model relating theory to practice and, as an exercise, applies the model to compare various early intervention programmes. In chapter two the editors of the book, Hom and Robinson, make some discursive remarks about recent trends and end their contribution with an argument for ' eclecticism in early education '. Almost without exception, subsequent chapters ignore Peters' attempt to work in a formal educational framework and opt for atheoretical eclecticism in respect of educational issues.

Seven out of the following nine chapters review the psychological literature on some aspect of early childhood behaviour; modelling, punishment, behavioural analysis, the use of incentive, pro-social behaviour, behaviour disorders and cognitive styles are each attended to. All the reviews are well organised, up to date and clearly written. The focus is, of course, on American studies but the student looking for a clear entry to any one of these fields will not be disappointed. Unfortunately attention to educational issues is very limited. Usually it takes the form of a final paragraph on implications and whilst most authors recognise the complexities of transferring ' findings ' to ' practices ' no systematic examination is made of this crucial problem. Treating educational psychology this way is rather like telling an aspiring lion-tamer the biological and performance characteristics of his splendid beasts and then putting him in the cage. Much of the literature reviewed is about the manipulation of children's behaviour. Why do we assume that changing our own teaching behaviour is so straightforward?

The exceptional paper in this volume does not make this assumption. The author is Marion Blank and she writes on the topic of teacher-child language interaction. She addresses herself to explicitly phrased educational questions and draws on psychological formulations of language interaction to develop a scheme for monitoring and improving the performance of child and teacher alike. The book is worth buying for Blank's contribution alone.

There is an added bonus. Paul Ammon presents a clear and concise account of the developmental theory of J. Pascual Leone. Ammon compares this theory with that of Piaget in terms of their respective utility to educators. The new theory looks interesting and deserves scholarly popularisation; Ammon achieves this.

With seven reviews of psychological literature on young children, Blank's excellent paper on language instruction and Ammon's popularisation of a potentially valuable developmental-instructional theory the book is worth £12·50 of any library's money.

CHARLES DESFORGES.

JONES, ANNE (1977). *Counselling Adolescents in School.* London: Kogan Page, pp. 200, £4·95.

During the last ten years or so, partly following trends in the United States and partly as a result of the growing complexity of secondary school life, the pastoral care of adolescent pupils in Britain has become increasingly professionalised. Expert personal, educational and vocational counselling is becoming more readily available in a growing number of schools. Yet, as the author of this book (an expanded and updated version of *School Counselling in Practice*) points out, there is still no official policy for developing school counselling, and in some schools the system of pastoral care remains largely haphazard and amateur. By no means every secondary school has a trained counsellor on its staff, and even where there are counsellors, their expertise is not always used to the full and their work is often misunderstood, not only by outside agencies but within the school itself.

In her book Anne Jones makes out a case for greater professionalism in counselling adolescent pupils while being anxious to integrate academic and pastoral concerns and to involve the school as a whole in pastoral care. She sets out to remove some of the current misconceptions about the role and functions of the school counsellor by explaining what different forms counselling can take, using selected case histories to illustrate the kinds of problem dealt with by the counsellor. In giving her ideas about the way in which counselling services should be established in secondary schools, she sees value in group as well as individual approaches. With experience as a teacher, counsellor and headmistress, Ms. Jones is able to look at the problems she discusses from a variety of angles. The advice she gives is generally sound and down-to-earth, and it is easy to see that failure to pay attention to some of the basic principles emphasised in this book could jeopardise the success of counselling in a school.

Throughout the book the importance of relationships is stressed. Anne Jones shows a sensitive understanding of possible role confusion among members of a school staff over responsibility for pastoral care, and is also fully aware of the need for school counsellors to build good relationships with parents and official agencies outside the school. Among other helping agencies, the school psychological service is mentioned in a positive way, as giving constructive help to the school, though it is a pity that more is not said about the ways in which the school, with support from educational psychologists, might prevent some adolescent problems from arising at all.

Overall, this is a useful if not very profound book, readable and, for the most part, clearly written. Anne Jones raises many pertinent questions which need further discussion. Most of her own views on these questions are well-argued and balanced, though not everyone will agree with her opinions about the training of school counsellors. While it seems reasonable for her to suggest that not all members of a school counselling service need prolonged specialist training, it can be argued that such a service should at least be headed by a fully trained counsellor (i.e. one with a qualification gained after taking a year's full-time course or its equivalent) and that all counsellors working within the school should have some classroom experience. One wonders, too, whether Ms. Jones is right in stating (p. 27) that only a small proportion of adolescents need personal (as opposed to vocational) counselling. However, whatever views are held on these points, the book can be recommended as helpful introductory reading for anyone concerned with adolescents in school. It should certainly encourage a more careful and thoughtful approach to pastoral care in secondary schools.

MAURICE CHAZAN.

KELLAGHAN, T. (1977). *The Evaluation of an Intervention Programme for Disadvantaged Children.* Windsor: N.F.E.R., pp. 145, £4·75.

WOODHEAD, M. (Ed.) (1976). *An Experiment in Nursery Education.* Windsor: N.F.E.R., pp. 123, £3·95.

Compensatory education at the pre-school stage is a complex and contentious field. Interventionists believe that if children arrive at school arguably ' defective ' in certain respects, it is our duty to identify such cases before school commences, preferably on the basis of previous research studies, and somehow enrich their pre-school experiences in such a way as to ensure that they derive optimum benefit from their schooling. Opponents assert that deprivation is a social myth and that some forms of enrichment are nothing more than the arbitrary imposition of one group's set of values on another.

A further complication for those initiating and evaluating intervention experiences is that the predominant contemporary style of British pre-school education tends to be informal, as compared with the much more systematically preordained structure of nursery education in the Soviet Union, or in such North American language enrichment programmes as those initiated by Bereiter and Engelmann.

A third problem at the present time is that massively funded enrichment operations such as Project Headstart in the United States have been heavily criticised by Jensen and others, and in most cases where follow-up occurred longer term effects were not demonstrated.

It is against this background that one reads these two books published by the NFER on the topic. Martin Woodhead describes a five-year project which ran from 1968 to 1973. A programme group of 155 children in four nurseries underwent a daily 20-minute session in which language and perceptual skills were developed in a systematic way. The principal source of inspiration was a modified form of the Peabody Language Development Kit.

Comparisons were made with 117 children in receipt of normal nursery education. Amongst criterion measures were five sub-tests of the Illinois Test of Psycholinguistic Abilities.

A number of studies have combined the Peabody Kit and the ITPA in curriculum development/evaluation work, and one wonders to what extent the action programme merely coaches for the test. Woodhead and his colleagues, however, readily identify any shortcomings in their procedures. Furthermore, having established some superior gains for the programme group, they were sufficiently concerned to follow the children through for two years into infant schools. Like others before them they found no differences subsequently between programme and comparison groups, this time on tests of reading and number. Despite this disappointment, confirming as it does that intervention needs to be sustained to have lasting effects, the book contains a great deal of interest, and its frank and open account of the project displays welcome honesty.

Kellaghan's intervention project also involved a five-year study of disadvantaged children. An experimental group of 85 Dublin children and two control groups of disadvantaged and non-disadvantaged children were studied. A largely cognitively-oriented action programme was mounted, designed to include parental involvement, and aimed at equipping children to cope better with school work.

On this occasion the follow-up was more encouraging than was the case in the Woodhead study. Some of the gains in the experimental group were sustained until the age of 8, though Kellaghan's use of a heavier experimental programme and a much larger battery of measures than Woodhead's may account for this.

Despite Kellaghan's careful opening scrutiny of disadvantage, the later prose is less taut than his very thorough numerical analysis. The too ready use of the code-equivalent ' middle-class ' as the antithesis of ' disadvantaged ' in sentences such as " Parents of disadvantaged children probably differ from parents of middle-class children in their attitudes towards, and guidance of the young child's exploration of his environment . . ." (p. 37) will incur the wrath of those who believe deprivation to be a social myth.

E. C. WRAGG.

LOVAAS, O. I. (1977). *The Autistic Child: Language Development Through Behaviour Modification.* London: Wiley, pp. viii + 246, £11·00.

The aim of this book is to help parents and professionals working with children who are seriously behind in their language development. The basic principles of learning theory and behaviour modification are briefly presented. The author then describes the steps in a language training programme which he has used with autistic children. To begin with, the child is trained to produce sounds, gradually leading on to whole words, which he is taught to use as labels for objects and events. The next stage is the development of understanding and use of the parts of speech that change their meaning with the user and the circumstances, such as pronouns, prepositions and words related to time. At a more advanced level, the child is taught to use language in a social context, and with correct grammar. Finally, methods of encouraging spontaneity in speech and the use of imagination through story telling are outlined.

The author discusses some of the theoretical implications of the results he presents, and defends the operant conditioning model of language acquisition, as applied to normal as well as handicapped children.

What are called ' language training manuals ' are included in the text. These give short and very basic outlines of the practical methods used in each of the stages of language development listed above. The last chapter presents, in some detail, descriptions of the progress made by three autistic children who were taught by the author and his colleagues.

The book has to be judged as a practical guide for people who are untrained in psychology, since this is its stated aim. But the author also invites criticism on scientific grounds, since he discusses theoretical ideas and presents his results as proof of the correctness of his views on language and on early childhood autism.

On the former count, the programmes described would be helpful for parents, teachers and others who are intelligent enough to understand the technical terms and abbreviations, persistent enough to learn them in order to follow the instructions, and inventive enough to devise ways of adapting the examples given to the needs of a particular child.

Any short practical manual can give only general principles and some concrete illustrations, but material of this kind is always welcome, even if it is not suitable for everyone who has to cope with a language-impaired child. However, the author could have gone much farther than he has in avoiding those technical words that are short-cuts around, and not essential additions to plain English.

As a scientific publication, the book has serious weaknesses. Evidence is accumulating that a structured educational programme can reduce behaviour problems, and may speed up the process of language acquisition, in those autistic children whose levels of intelligence and behaviour patterns in early life suggest a favourable prognosis for language development, whatever educational methods are used. The position regarding the effects of special teaching in children for whom initially the prognosis appears to be poor is still uncertain. Firm evidence on this issue would be most valuable, but Dr. Lovaas ignores the necessity of evaluating a therapeutic technique by comparison with the results of other methods, and with the natural outcome in the absence of any special treatment.

The author's discussion of the possible causes of the autistic child's language problems is markedly inadequate. His main reason for dismissing the reasonable possibility that there may be areas or functions of the brain specifically concerned with language and social communication, which might be affected in autism, appears to be that belief in such an organic basis to the problem would remove any incentive to help the children through education. There are two fallacies here. First of all, the truth of a proposition is not affected by any supposedly harmful consequences of holding it; second, many of the most successful teachers of autistic children who use operant methods, among others, do accept the evidence in favour of an organic cause for the language impairments. If Dr. Lovaas wishes others to agree with his theories, he must produce appropriate proof, which, so far, he has signally failed to do.

LORNA WING.

PIAGET, J. (1977). *The Grasp of Consciousness: Action and Concept in the Young Child.* London: Routledge and Kegan Paul, pp. vii + 360, £8·50.

Young children can carry out acts of practical intelligence before they can explain how it is that they are successful. For example they can hit a target with a ball released from a string before they are consciously aware that they do, in fact, release the ball from the sling at a tangent to the target. When asked what happens young children maintain that the ball is released directly in front of the target. This book is about the stages whereby children become fully conscious of their actions in the sense that they can explain what happens in words, by drawing or by gesture.

With the aid of 14 collaborators 15 different tasks were studied. One chapter in the book is given over to each study. The sixteenth and final chapter in the book is devoted to an account in genetic epistemological terms of how this consciousness is arrived at. All of the tasks were selected on the basis that they were likely to be encountered by children in some form or another in their everyday lives. They are a curious assortment: squeezing a ping-pong ball so that it returns to base, tilting a cardboard lid so that a counter slides along particular paths, building a ramp for a toy car, playing tiddleywinks, walking on all fours and so on. However they all require an accurate appreciation and use of kinaesthetic, kinetic and mechanical knowledge. Each chapter follows the same format. First the task and its variations are described followed by descriptive examples of children's attempts at these tasks and their explanations of what took place. The ages of the children appear to have ranged from 4 years to 13 years. Sometimes the total number of children taking the task is incidentally included. Selected examples of children's attempts at these tasks are used to support a distinction of two or three levels or stages through which by a process of conceptualization involving language and mental imagery action attains conscious form. Each chapter is enveloped with a generous covering of opaque terminology.

It is a highly unreadable book. Not only does the reader have the problem of peering through the gloom cast by the obscure prose in order to discern the meaning but he also has the difficulty of visualising the concrete and specific events to which the great mass of verbal descriptions refer. Despite the fact that for these studies to be followed in detail one would need to see the children attempting them there are no pictures in the book and only six diagrams. The author and his collaborators have the advantage over the reader that they have already seen what they are talking about so they no longer require the sort of visual specificity that the reader does. Another reason for the obscurity of the text may well be the author's self-acknowledged preference for thinking in words rather than with visualised forms. In a footnote on page 342 he tells the reader that he has a far better auditory than visual memory. He can never remember the time on his watch unless this visual perception is accompanied by a sufficient verbal formulation. If it is not, he has to take out his watch again a moment later and, seeing virtually the same time, recognises that he has already perceived it a moment before, but without any recollection. Doubtless this new book of Piaget's will in due course be followed by a small army of interpreters. I would suggest that any attempt to explain this book by another book will be largely useless unless it is full of pictures, diagrams and drawings or better still it would not be a book at all but a film.

As usual Piaget does not attempt to accommodate his observations to the research or theoretical perspectives of others. The only other reference to research other than Piaget's own is that of Hermine Sinclair's article on the ' Acquisition of Language and the Development of Thought ' on page 307. However, on page 12 we are referred to an encyclopaedia published in 1751 which tells us that the children in the Balearic Islands were particularly good with a sling because their mothers used to hang their bread on the end of a pole and make them go hungry until they had hit it.

To my mind, apart from the occasional light relief inadvertently provided by such remarks as this, the most interesting and useful aspects of this book are not the theoretical ones such as announced on page 334 that the general law that seems to emerge from their findings is that cognisance (consciousness of actions) proceeds from the periphery to the centre but the ingenious variations of the tasks that were undertaken to explore the limits of children's awareness and the surprising preconceptions they reveal.

LAWRENCE LITT.

RUTTER, M., and MADGE, N. (1976). *Cycles of Disadvantage*. London: Heinemann, pp. vi+413, p. £2·50, c. £6·50.

Anything written by Michael Rutter is worthy of every educational psychologist's consideration. His contributions to the literature on maladjustment and more severe psychiatric disturbances of childhood, the developmental consequences of different forms of parent-child interaction, specific reading difficulties and a variety of other topics have done much to counter-balance the strong wave of anti-psychiatry feeling that seems to have reached almost hysterical proportions amongst some child psychologists during the past few years. Even if the reader disagrees with the perspective that Rutter, as a brilliant psychiatrist with a strong commitment to classification, brings to his data, he is always guaranteed a clarity of thought and economy of expression that is certain to warrant his full attention.

Rutter's latest publication, the authorship of which he shares with Nicola Madge, is no exception. I understand that much of the far-ranging review of an immense literature reported therein was carried out by Nicola Madge whilst working on a research grant at the Institute of Psychiatry, but that the book itself is truly a joint effort. This certainly shows in that the book stands out as a first-class example of scholarship, clear thinking and sheer hard work. On that score alone it cannot be faulted. It is packed with information, beautifully referenced and sensible in its refusal to be drawn into the polemics of political debate in an area that has already received more than its fair share of the latter.

The introductory chapter concerns itself largely with a masterful presentation of the methodological difficulties confronting those with the temerity to carry out research and seek to interpret its findings in this highly complex area. The authors' starting point was Sir Keith Joseph's notorious ' cycle of transmitted deprivation ' speech and their aim was to review the evidence on how far this existed and the ways in which it occurred. They soon found such an aim to be unrealistic in that the implications of the original phrase were so far-reaching as to be meaningless. This in itself necessitated a change in terminology, perhaps the most important aspect of which was the substitution of ' disadvantage ' for the oft indiscriminately used ' deprivation '. They sensibly recommend that the latter term be abandoned on the grounds that " the word almost functions as a projective test in which each person reads into the concept his own biases and prejudices, regardless of how the word has been used in the article or book in question ".

With their title established the authors then go on to reiterate that the book is intended as a research review alone with all the methodological difficulties and pitfalls entailed therein and not as a theoretical treatise presenting one or another point of view. In this they succeed admirably, perhaps even too well since there are times when this reader at least found himself yearning for some form of commitment to one viewpoint or another. There are times when an over-determined effort to present a balanced viewpoint can become terribly dry, but this is perhaps to carp too much.

In deciding which types of disadvantage to cover in their review, the authors referred once again to Sir Keith Joseph's original speech and added certain others that seemed important. The book devotes a chapter each to economic status, housing, intellectual performance and scholastic attainment, occupational status, crime and delinquency, psychiatric disorder, parenting behaviour, multiple problem families and ethnic minorities in Britain. Herein lies both the book's strength and possibly its major weakness. It is almost encyclopaedic in its coverage but also has a tendency at times to try to cover too much. It soon becomes clear that each of the above topics both deserve and perhaps also need a book to themselves and warrant more than the linking theme of ' disadvantage ' to bring any real sense of coherence to their inclusion side by side in one text. The authors almost go as far as admitting this themselves when they point out the impossibility of drawing general conclusions from all of the topics taken together. In many respects each chapter stands alone and can be considered independently. Where they are drawn together is by the excellent introductory and concluding chapters that devote their attention largely to methodological and conceptual issues of central importance above and beyond any single topic covered.

A detailed consideration of the 59-page chapter on intellectual performance and scholastic attainment should help to illustrate some of the above points further. The pages are packed with information on research into a variety of subtopics, but one has the feeling at times that the selection has been somewhat idiosyncratic. The introduction to intelligence and its measurement suggests that certain ' facts ' about the construction of IQ tests are not in dispute. This is not true. There is a great deal of dispute over whether intelligence test items call upon specialised knowledge or whether the skills assessed are a result of direct teaching. However, here and elsewhere throughout the chapter a great deal of available evidence is marshalled both for and against the main opposing viewpoints and balanced conclusions are drawn on such issues as the relationship between low IQ and delinquency, family size, and mental retardation, the heritability of intelligence, physical disabilities, the influence of low birth rate and the effects of malnutrition. Some of the references quoted are very old, but that may just reflect the lack of recent research, whilst rather a lot of others are by Rutter *et al.*, even on one occasion (Yule and Rutter, 1976) where no publication exists. If the social implications of reading failure were considered worth reviewing they surely warranted more than one brief paragraph. Presumably they weren't just included because three of the four studies reviewed were by Rutter and/or his colleagues. Similarly, there is a great deal more research on specific educational disabilities than we find referred to here and the far too brief section on the relationship between personality factors and school achievement leaves a great deal of research unmentioned.

On reflection I feel that most of my criticisms of this book represent little more than quibbles. Taken as a whole I find it an excellent work of scholarship. At £2·50 for the paperback edition I can think of little better value for money. It deserves to sell in large numbers.

R. L. Burden.

Treffinger, D. J., Davis, J. K., and Ripple, R. E. (Eds.) (1977). *Handbook on Teaching Educational Psychology.* London: Academic Press, pp. xv + 352, £12·80.

Educational psychology it seems is all things to all men. A tutor of teachers in training, an educational psychologist with a local education authority, an academic lecturer or a research worker would all define this field of study in different ways. This book, each chapter of which is a paper by different authors, does not really succeed in the definition which it attempts. It is an American book and therefore refers to an educational system differing in many ways from that with which the British reader is familiar. In general the papers treat educational psychology as an academic discipline with particular reference to teacher training. It is oriented towards theoretical principles; there is little of detail and although it speaks of practical applications there are no exemplars. In fact a great deal of the material is equally applicable in the teaching of any subject.

The book is in four parts: the nature and organisation of educational psychology, general conceptual and intellectual models, specific instructional approaches and a summary of teaching at undergraduate and graduate levels. Many sections suffer from over-condensation and become misleading for the less critical reader. There is a " it's Wednesday afternoon and therefore this is Rome " approach; for example psychological theorists receive eight pages in one paper, in another historical antecedents have three and a half pages, educational psychology textbooks three. Educational research is stressed. We are told " Educational psychology is essentially a research oriented discipline " and again " Educational psychologists are renowned for educational research with their own students (college level) and attempting to generalise to all levels of students " ! Of course research methodology is a part of educational psychology and indeed this book has a chapter on methods of enquiry but this seems to have been included as an obligation and not as an integral part of the text. The conceptual and theoretical models are confined to three. The first, an applied behaviour analysis approach, is a fairly traditional overview but within the compass of a single paper is reasonably comprehensive. The second approach—the cognitive point of view—attempts too much in a single chapter and its main contribution is task analysis strategy. Finally we have the humanistic approach. It is a good summary of humanistic philosophy and its relevance to teaching and learning. It must be admitted however that the outline does not emphasise those things that pass for humanistic psychology in this country.

The best parts of this book are the six chapters devoted to specific instructional strategies. These would be helpful to any new teacher not only in this field but in almost any discipline. They range through mastery learning and competency based programmes, to the management of learning environments and personalised instructional systems. The paper on future trends was perhaps the most interesting. One idea which may surprise some of our educational psychologists was the application of psychology to education literally from the cradle to the grave with some emphasis on the educational needs of the retired. The remarks on ' mainstreaming ', that is the education of the handicapped in ordinary classes, are of some current interest in view of the implications of the 1976 Education Act. The future trends in the political aspects of educational psychology which are described are somewhat disturbing. The censorship of school textbooks whether on sexist, racist, religious or other grounds has fortunately not really raised its ugly head in this country. The cry that restriction of access to school records will constrain research seems of less importance. Surely one would hope the researchers would collect their own data rather than rely on other people's records of unknown validity.

On the whole this expensive book is disappointing, especially so, since some excellent texts have come from this press in the past. It will be of some interest to lecturers, particularly those engaged in training teachers. It cannot be recommended in any other context.

Alec Walbridge.

Tucker, N. (1977). *What is a Child?* London: Fontana/Open Books, pp. 128, p. £1·00, c. £3·50.

Stern, D. (1977). *The First Relationship.* London: Fontana/Open Books, pp. 159, p. £1·25, c. £4·50.

Bower, T. (1977). *The Perceptual World of the Child.* London: Fontana/Open Books, pp. 93, p. £1·00, c. £3·50.

Goodnow, J. (1977). *Children's Drawing.* London: Fontana/Open Books, pp. 171, p. £1·25, c. £4·50.

This is the second batch of short books on *The Developing Child,* edited by Jerome Bruner, Michael Cole and Barbara Lloyd. Their aim is to cover the major advances that have occurred in recent years in our knowledge of infant and child development. While sufficiently non-technical to appeal to parents and teachers, they also contain enough meat to be worth the attention of psychology and education students. It is unfortunate that this simplification has extended to the abbreviation of indices; in the first three of these titles the subject index occupies one and a half pages or less.

Dr. Tucker's book gives an admirable introduction which should be perused before proceeding to the more specialised books in the series. However its range is so wide that it cannot deal with any topic in much depth. It is highly readable, and is enlivened by literary quotations, and comparisons of present-day children in western societies with children in the past, or in other cultural groups. Perhaps the oustanding merit is the reasonable course that the author steers between emphasising cultural differences on the one hand, and drawing attention to the evidence of biological or genetic influences, common to all mankind, on the other hand.

Dr. Stern is a psychiatrist who makes very little use of experimental investigations and indeed seldom refers to the work of psychologists. He relies mainly on his observations and those of colleagues, sharpened by high-speed photography of mother-child interactions; and he insists on observing in natural home situations rather than laboratories. To a large extent his conclusions coincide with those of R. Schaffer (in the earlier book in this series, called *Mothering*). But he goes into much greater detail than most psychologists in analysing the ' repertoires ' of mothers and of infants mostly between the ages of 3 and 8 months. Characteristic changes of facial expression, gestures, vocalising, tactile and kinaesthetic stimulation, are described, together with their integration into social interchanges and play. The behaviours are aptly compared to a game of tennis, or a waltz, where the partners' actions are interdependent, and guided by mutual feedback. While there is a great deal of repetition in such interactions, there are also variations such that the infant is helped to build up the schemas which underlie his cognitive, motor, and social development. Dr. Stern emphasises that the infant is an active seeker for experience, not a *tabula rasa,* and that the maternal behaviour is remarkably spontaneous and unselfconscious, suggesting that she has a kind of innate ' knowledge ' of how to stimulate her baby. Psychologists who are shocked by such a mentalistic theory are advised to read this book. This is in no sense a Dr. Spock manual, though the author does mention the probable harmful consequencies of over-intense, or too apathetic or insensitive, stimulation by the mother. He doubts whether mothers can be trained to perform better, thus ignoring the apparent success of programmes recently described by Karnes and Teska, Levenstein, and others.

Dr. Bower's book provides a contrast, since it derives primarily from experiments conducted by himself, or others, which demonstrate the perceptual capacities and limitations of children from birth up. A main theme is that infants are born with considerable potentialities (one of the most striking being Wertheimer's finding that they can distinguish right and left auditory stimuli shortly after birth). But an enormous amount of practice in seeing, reaching, hearing, and feeling is necessary for tying down these skills so as to make sense of the world around them. Bower also covers the development of constancies and object permanence, the transition from complete dependence on perception to the interpretation of perceptual input in the light of stored knowledge, and the special handicaps of children born deaf or blind. The book does not go much beyond his own *Development in Infancy* (1974), but is certainly easier reading.

Finally, Dr. Goodnow's book on young children's drawings is rather disappointing, since it deals almost entirely with the rules or principles that seem to underlie their oddities.

For example: human figures must always lie along an axis 90° to the ground (the bottom of the paper); and no two parts, such as hair and arms, must overlap. The variations in the way these rules are applied by different children of the same or different ages (or by the same child at different times) are traced in detail, and illustrated with numerous line drawings, which are very apt though sometimes too small to be comprehensible. Thus scarcely any attention is paid to the psychological ' meaning ' of particular characteristics of the drawings, such as their dependence on the child's conceptual level or his intelligence, or how far they reflect personality differences. Some recent work on drawings is referred to, though no mention is made of Burt, Goodenough, Harris, or Witkin. However the psychologist, and perhaps the parent or teacher, will find plenty to interest him, and to stimulate further enquiry.

P. E. VERNON.

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Books for review have been selected from the following ('n.p.' means 'no price mentioned').

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SUMMARY. Recent research on representations of knowledge and styles of learning carried out by Pask and his colleagues is summarised and discussed in relation to earlier work. The claims made for the wide applicability of conversation theory to learning and teaching in schools and higher education are considered in the light of the evidence presented to date.

INTRODUCTION

FOR people not previously familiar with his work, Pask's most recent progress report on his SSRC research programme (Pask *et al.*, 1977) presents formidable difficulties. Complex theoretical ideas derived from epistemological considerations are expressed in what amounts to a new language—a whole string of invented terms together with redefinitions. This theoretical structure is then allied to descriptions of specially developed computer programs, and to equally complex descriptions of the knowledge structures found in esoteric subject-matter areas, particularly in the sciences. The range of prior knowledge necessary for a full understanding of Pask's research is rarely to be found. Even to come to grips with the main message being presented by Pask and his colleagues is extremely difficult. It may thus be helpful to examine the most recent work against its earlier background.

PREVIOUS WORK ON CONVERSATION THEORY AND LEARNING STYLES

Conversation Theory

The rationale for much of the work presented in the progress report can be found in the formal description of *Conversation Theory* (see Pask 1976a). Essentially this theory describes learning in terms of a conversation between two representations of knowledge. In the most familiar situation these representations reflect the cognitive structures of two people, the teacher (or subject matter expert) and the student. Learning takes place through a dialogue between the two and, in conversation theory, understanding has to be demonstrated by applying that knowledge to an unfamiliar situation in a concrete non-verbal way (often using specially designed apparatus). Reproductive responses based on memory are not accepted as evidence of understanding.

Learning need not, however, involve an interaction between the cognitive structures of two people. The student may converse silently with himself in trying to understand a topic, or he may interact with a formal representation of the knowledge structure and supplementary learning materials which have been specially designed to facilitate understanding of the chosen subject-matter area. Such a ' surrogate tutor ' is described as a *conversational domain* in a standard experimental condition, and contains three main components:

(1) *An entailment structure* which is a concept map of the subject area which fulfils certain requirements to ensure its coherence, consistency, and cyclicity (to enable a student to reconstruct for himself the meaning of a concept of a topic). The entailment structure normally involves a domain of theoretical topics, exactly paralleled by a set

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of analogous topics drawn from ' real world ' examples. A third domain contains topics which explain the nature of the analogies between the two main domains. Essential characteristics of these entailment structures are that topics are shown as a hierarchy with prerequisite topics clearly indicated, that relationships between topics are shown, and that the student does not have to tackle all the topics in a single predetermined sequence. There are, however, strictly enforced rules which ensure that no vertical progress through the hierarchy can be made until thorough understanding of all prerequisite topics has been demonstrated, although advance ' exploration ' is allowed.

(2) *A computer* to control and record the order in which topics are studied and to check whether the student has effectively demonstrated the understanding of each topic.

(3) *Learning materials*, including tape/slide presentations, printed explanations of topics, and apparatus for the practical illustration of analogies and for allowing the student to demonstrate understanding. The main advantage of the standard conversational domain is that it exteriorises the learning process in a way which enables students' strategies to be investigated. It also provides an ' ideal ' learning environment against which real learning situations can be contrasted and weaknesses detected. However, the standard condition has the disadvantage, shared by most experimental arrangements, that it produces artificial constraints on normal learning strategies. Pask has therefore used both standard conditions (CASTE and INTUITION are the names given to laboratory and portable models of this apparatus) and free learning conditions where the student explains his strategy verbally (TEACHBACK).

Learning styles and strategies

The first set of experiments reported by Pask and Scott (1972) used a set of information cards from which students were required to work out the taxonomies of a species of imaginary Martian animals—the Clobbits. This was a free learning condition. The cards were placed face downwards in rows presenting different categories of information for each of the sub-species (columns). Following Bruner's procedure in concept learning (Bruner *et al.*, 1956) students were asked their reasons for choosing each card in the order they did and, when they had deduced the taxonomies, they were required to explain to the experimenter what they had discovered (hence TEACHBACK). From the transcripts two distinct learning strategies were identified, which were comparable to two of Bruner's categories. *Serialists* (partists) followed a step-by-step learning procedure concentrating on narrow simple hypotheses relating to one characteristic at a time. *Holists* (wholists) tended to form more complex hypotheses relating to several characteristics of the organisms. In TEACHBACK, differences between the holists emerged. *Irredundant holists* made use of analogies in their explanations which were appropriate and correct. *Redundant holists* made, if anything, wider use of analogies but many of these were not strictly accurate and some were entirely fictitious, invented to help the student remember certain characteristics of the animals. These personal ' props ' seem to be the mark of the extreme holist.

The next step in this experiment was to discover whether students matched with programmed learning materials designed to suit their learning style learned faster and better than students who were mismatched. The learning materials taught another set of imaginary taxonomies, the Gandlemüller. The holist programme contained a great deal of ' enrichment material ' which encouraged the wide use of analogical relationships, while the serialist programme was severely limited to step-by-step logical progression with a narrow focus. Students in the matched condition (holists with holist materials etc. . . .) obtained much higher post-test scores than those who had been mismatched.

The term ' holist ' and ' serialist ' are used to describe the distinctive strategies students adopt in tackling the experimental tasks given to them. They are identifiable equally well in both free learning and in standard experimental condition. Perhaps the clearest way to illustrate the differences between these characteristic learning strategies is from contrasting TEACHBACK responses. First a serialist and then a redundant holist describe what they had discovered about Gandlemüllers:

> " Zoologists have classified the Gandlemüller on the basis of physical characteristics. The three main types are Gandlers, Plongers, and Gandleplongers. Gandlers have no sprongs. Plongers have two sprongs. Gandleplongers have one sprong. There are four sub-species of Gandler: M1, M2, B1, and B2. The Ms have one body, the Bs have two bodies. The M1 and B1 have a single cranial mound. The M2 and B2 have a double cranial mound . . ." and so on.

That of course was a serialist; now for a holist:

> " I want to tell you about a funny Martian animal which has been recently discovered and classified by scientists conducting surveys. They are funny slug-like things with various protuberances. These animals are called Gandlemüllers, because they churn about in the swamps near the Equator and Gandle is Martian for swamp-mud, hence swampmudmiller. (Müller is German for miller.) These things churn through the mud eating it by some curious process which means they eat and excrete at the same time. . . ."

But Pask argues that underlying these apparatus-specific strategies are psychologically more fundamental *learning styles.* To quote Pask (1976b, p. 133):

> " The holist/serialist distinction . . . is an example of different learning strategies, rather than the more generally exhibited learning style . . . Holism and serialism appear to be extreme manifestations of more fundamental processes, which are induced by systematic enforcement of the requirement for understanding . . . If the strict condition is relaxed as it is in class tuition or self-study, some students are disposed to act ' like holists ' (*comprehension learners*) and others ' like serialists ' (*operation learners*), with more or less success. There are also students able to act in either way, depending on the subject matter, and if they excel in both pursuits, we refer to those students as *versatile.* It is these distinctions which can, more appropriately, be referred to as learning style."

Following from these strategies are inevitable learning pathologies. The holists' search for rich analogies leads to the use of inappropriate ideational links, a pathology Pask calls ' *globetrotting* '. The serialists often ignore valid analogies and so suffer from ' *improvidence* '. Both pathologies hinder students in their attempt to understand the learning materials.

Pask's most recent descriptions of these styles of learning (Pask *et al.*, 1977, p. 68) have underlined the importance of this distinction. But it now seems that comprehension and operation learning are seen as essential components; as extreme styles they each represent an incomplete approach and hence a pathology.

> " The term *comprehension learning* is used for that facet of the learning process concerned with building descriptions of what may be known. *Operation learning* is the corresponding term for the facet of the learning process concerned with mastering procedural details. A bias to one or other of the two aspects of the learning process leads to consistent pathologies of learning. Comprehension learning that is not grounded in operational mastery leads to *vacuous globe trotting*; operational learning that is not accompanied by the comprehension of valid analogies between areas of subject matter leads to *improvidence.*

> " A student who is *versatile* is not prone to vacuous globetrotting; he does indeed build up descriptions of what may be known by a rich use of analogical reasoning, but subjects the hypotheses to test and operationally verifies the validity of an analogy and the limits of its applicability.
>
> " By the same token, the versatile student is less likely to show the improvidence of failing to see that one area of knowledge (which has been operationally mastered) is analogous to a second area (which is to be learned)."

A further extract from the current report (p. 149) clarifies how comprehension learning and operation learning can be *both* essential components of the learning process *and* descriptions of distinctive styles.

> " The distinction stems directly from the theory of learning and teaching embodied in CASTE: comprehension learning is that aspect of learning concerned with building descriptions of *what may be known* in a subject matter area (in CASTE an entailment structure provides such a description); operation learning is that aspect of learning concerned with *mastering operations and procedures* which satisfy descriptions (in CASTE these are characterised by the task structures associated with each topic in the subject matter area). In principle, both comprehension learning and operation learning may be done in a ' local ' or ' global ' manner using a few or many sources of information. Some comprehension learning and *some* operation learning are needed for understanding, but people may be better at one or the other.
>
> " In practice, comprehension learning, that spans (possibly) several subject matter areas, benefits from a ' global ' approach. In contrast, mastering the procedural details of particular tasks often requires a ' local ', one step at once, approach."

In these early studies, learning strategies were inferred from the actual learning tasks either in the ' Clobbits ' taxonomy (Pask and Scott, 1972) or in the order in which topics were tackled in CASTE or INTUITION (Robertson, 1976, 1978). But these approaches are time-consuming and inexact; they lead only to dichotomous classifications into holists and serialists. It was necessary to develop an independent measure of the three learning styles subsequently described. As a result two tests have been developed—The Spy Ring History Test and a parallel form called the Smugglers Test.

The Spy Ring History Test

To bring out the meaning of the scores on comprehension learning, operation learning and versatility, it is necessary to provide a brief indication of the nature of the task presented.

" As its name suggests, the test task requires the respondent to learn about the history of a spy ring (the activity and form of an espionage network involving five agents and three countries over a period of up to five years).

" That the scenario concerns spies and fictitious countries is not important. What is of importance is the structure of the task (which requires strong measurable components of comprehension learning, operation learning and versatility).

" The comprehension learning component concerns the student's ability to learn the similarities and differences between a set of networks (connected graphs) which show what communication links existed in a particular year of the Spy Ring's existence. . . . The operation component concerns the student's ability to learn the roles played by particular spies so as to reconstruct representative sequences of actual transactions for a particular year.

" The chief measure of versatility is the ability to infer a plausible ' next stage ' in the Spy Ring's history. A good prediction requires an appreciation of the symmetries and asymmetries in the network patterns as a cycle of changes (comprehension learning) and a mastery of the roles and rules that govern a representative sequence of messages actually transmitted from one spy to another (operation learning).

" A fourth component of the task is a ' neutral ' score. It is computed on the basis of a student's ability to recall facts concerning the scenario presented to him in his briefing that are not directly relevant to the learning of network formats and message sequencies (personalities of spies, geography and politics of countries).

" A (low) ' neutral ' score may reflect the (limited) extent to which a student was attending to the task . . . while (a high score may indicate that), for some students, the ' irrelevant ' data . . . are in fact (personally) highly relevant. The student embeds his learning of network and lists of messages in the context of places, people and politics " (Pask *et al.*, 1977, pp. 150-151).

RECENT DEVELOPMENTS

The progress report mentioned earlier (Pask *et al.*, 1977) can be summarised under a series of headings which are related to the sections in that report.

(i) The theoretical model (section 5).
(ii) Alternative representations of knowledge structures (sections 5 and 3.5).
(iii) Teaching ' troublesome ' topics (section 2).
(iv) Learning to learn (sections 4 and 6).

The theoretical model

Perhaps the most significant development in the theoretical model outlined previously (Pask, 1976a) is the recognition that the conversational domains provided in the CASTE and INTUITION systems were too restricted. The entailment structures presented the student with a fixed view of the subject area which represented the subject specialist's own understanding of the topic area. Also the emphasis within the conversational domain on *mechanical* models and analogies fails to do justice to the rich variety of analogical ideas exhibited by holists in free learning situations.

Pask comments that:

> " The valid analogies which promote rapid assimilation of meaningful data are often of a much more complex, idiosyncratic type than the material analogies of form so far discussed " (Pask *et al.*, 1977, p. 136).

Alternative representations of knowledge structures

The previous fixed entailment structure provided in the conversational domains can now be overcome by making use of an epistemological laboratory (THOUGHT STICKER) made up of computer programs and associated autonomous microprocessors and graphics facilities. This system allows the student to interact with the topics so as to match their hierarchical arrangement and sets of interrelationships to his own idiosyncratic view of the subject area. This development capitalises on the recognition that subject matter specialists impose their own distinctive structures of topic areas in their teaching, and provides the same facility for students.

Previously the final entailment structure was obtained by simplifying and formalising (pruning) the looser topic map (entailment mesh) provided by one or more subject specialists. Now it is possible to see a variety of equally valid entailment meshes (pruning field) as being " analogies of method " in representations of knowledge structures. THOUGHT STICKER adds this facility to the existing " analogies of form " which had already been incorporated between theoretical and real-world topics in the earlier entailment structures.

Teaching troublesome topics

A conversational domain provides what is seen to be an ideal learning environment. Normal teaching and learning situations in schools or higher education rarely, if ever, match up to the requirements of conversation theory in ensuring that a deep level of understanding is *necessarily* reached. If, therefore, there are topics which are consistently found to be ' troublesome ', it is reasonable to examine whether they are being taught in ways which fall seriously short of the ideal model. It should then be possible, in analysing these topics, to identify shortcomings either in the way the subtopics are interrelated, or in the explanations or analogical models being provided.

Pask and his colleagues report several separate studies in which teachers have been helped with troublesome topics. Although in most cases it is the teachers who have brought these topics to the notice of the research workers, students have generally agreed that these parts of the course have created particular difficulty. The problems will be most severe, of course, for students who adopt a superficial reproductive or *surface approach* (see Marton and Säljö, 1976) to learning. One of the troublesome areas was identified in the Biology A-level course.

> " Meiosis and mitosis (in genetics) are both mechanisms for cell division; as such they have striking similarities and dissimilarities (both of process and terminology). Because of the similarities, students frequently confuse the two. This is especially the case when they fail to appreciate the roles the two processes play in the larger context of genetics: the variety of organisms and the evolution of species. The student who is concerned only with his ability to reproduce a series of diagrams and their associated labels is particularly prone to error of this kind " (Pask *et al.*, 1977, p. 17).

In the conversational domain, understanding is fostered by encouraging the student to explore concepts and relationships in concrete terms using appropriate models which can be manipulated in various ways (modelling facility), and by providing a clear guide to the relationships between concepts in the entailment structure. Thus attempts to improve understanding of meiosis and mitosis have centred on the development of a ' gaming board ' which allows the student to explore the combinatorial possibilities involved in cell division. Tutorial materials explain and govern the use of this modelling facility. Finally an entailment structure for the topic has been devised.

Evaluation of the effect of this innovation has been hampered by a lack of control over the samples, the differing ways the materials have been used by the teachers and also by serious time-tabling constraints. The effectiveness of this intervention is thus still uncertain, although unpublished work in progress does provide firmer evidence of the success of this approach. With a sample of some 75 students, those working with these materials generally reach a full understanding of these difficult topics, while those taught by conventional methods tend to have less than half of the post-test questions correct. Students making use of the entailment structures of the topics also show higher levels of understanding than other students. (Pask, personal communication.)

Similar intervention strategies have been developed in A-level Physics (the nature of the photon), A-level Nuffield Chemistry (reaction kinetics and equilibria) and mathematics for 11 to 13-year-olds (fractions). The evaluation of these projects is still incomplete, but again preliminary results are promising.

Learning to learn

It is possible to derive from conversation theory guidance for students as well as for teachers. Students often fail to grasp important relationships between concepts or sub-topics, and they may also fail to recognise possible weaknesses in their approach which are attributable to their particular learning style. As it had been found that students given the opportunity to learn under a standard experimental condition (CASTE or INTUITION) developed learning skills which carried over into normal studying, a series of experiments and workshops have been set up to try systematically to improve students' learning skills.

> " The experiments were divided into three sessions. At the first session, students were told they were being placed in the position of a student who failed to attend a lecture course and has the task of revising for an examination. Apart from knowing the title of the course, the student has at his disposal the set texts and extracts that were required reading for the course. He has at most four hours in which to read and study the texts.
>
> " The second session was devoted to training. A study guide was provided which laid out principles of learning and knowledge structuring in a simple, non-technical manner, and took students through a similar exercise of coming to grips with a superficially disparate set of text extracts.
>
> " The final session was identical to the first and served as a post-test training evaluation.
>
> " At the end of both sessions 1 and 3 tests and interviews were given. As well as answering a short factual test, students were asked questions requiring essay type answers. Finally, they were asked to produce entailment graphs showing how they saw the relationship between topics in the several subject matters " (Pask *et al.*, 1977, p. 69).

In later experiments the Spy Ring History Test was administered to enable comparisons to be made between scores on the test and the complexity shown in the entailment graphs produced (see Figures 1 and 2). These entailment graphs provide useful evidence of the way students understand the topics studied.

A series of small-scale experiments have now been completed, together with a larger scale intensive workshop. Again difficulties were experienced in schools because of the length of uninterrupted time required for the training sessions, but some interesting results have been reported.

> " The findings were most encouraging: our earlier studies gave evidence that students can learn to learn and build descriptions of unstructured materials; this study shows that the description built up by a student (his entailment graph) has distinct personal characteristics reflective of his (learning) style " (Pask *et al.*, 1977, p. 77).

The graphs produced for two separate topics (Bateson's thesis on the ecology and evolution of mind, and a history of Henry VIII) by 15 lower sixth formers showed a close agreement based on Q analysis. There were also substantial and significant correlations (0·72 on Bateson and 0·50 on Henry VIII) between the degree of complexity and connectivity in the graphs and the comprehension learning scores. Similarly high correlations (0·77 and 0·53) were reported between operation learning and the proportion of ' correct ' connections (in comparison with the ' master ' entailment structures). The scores on comprehension learning and operation learning were independent in this sample ($r = 0{\cdot}03$).

In most of the experiments it was clear that the training sessions had had the desired effects. Performance on test questions improved from session 1 to session 3, and the complexity and connectivity of the entailment graphs also increased.

> " The students who show least improvement in terms of test scores tend also to be those who are intransigent operation learners, that is, their operation learn-

FIGURE 1

GROUP ENTAILMENT GRAPH FOR REACTION KINETICS

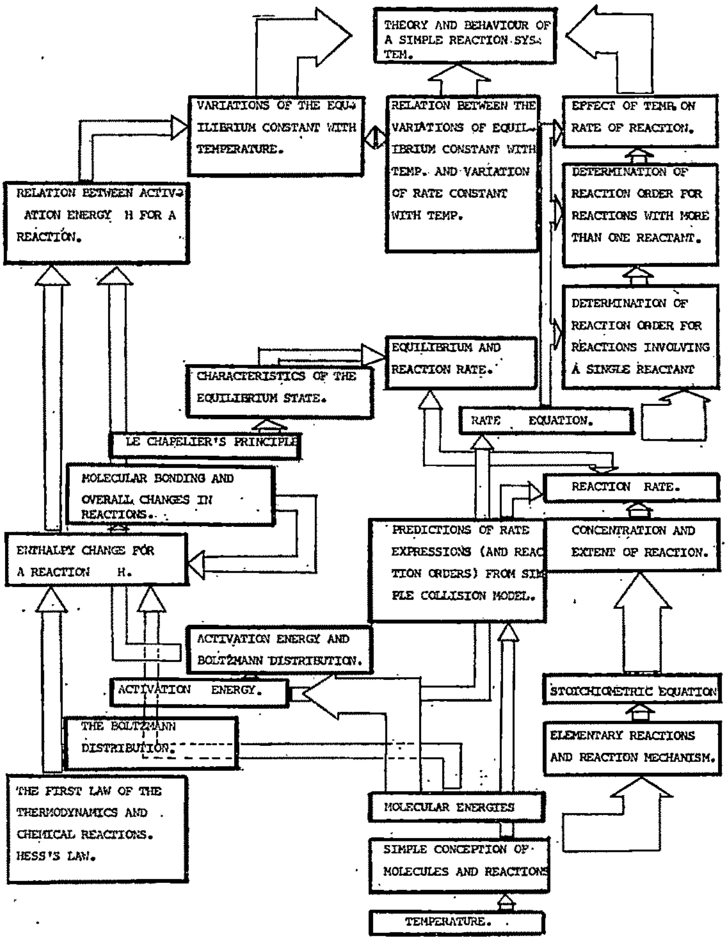
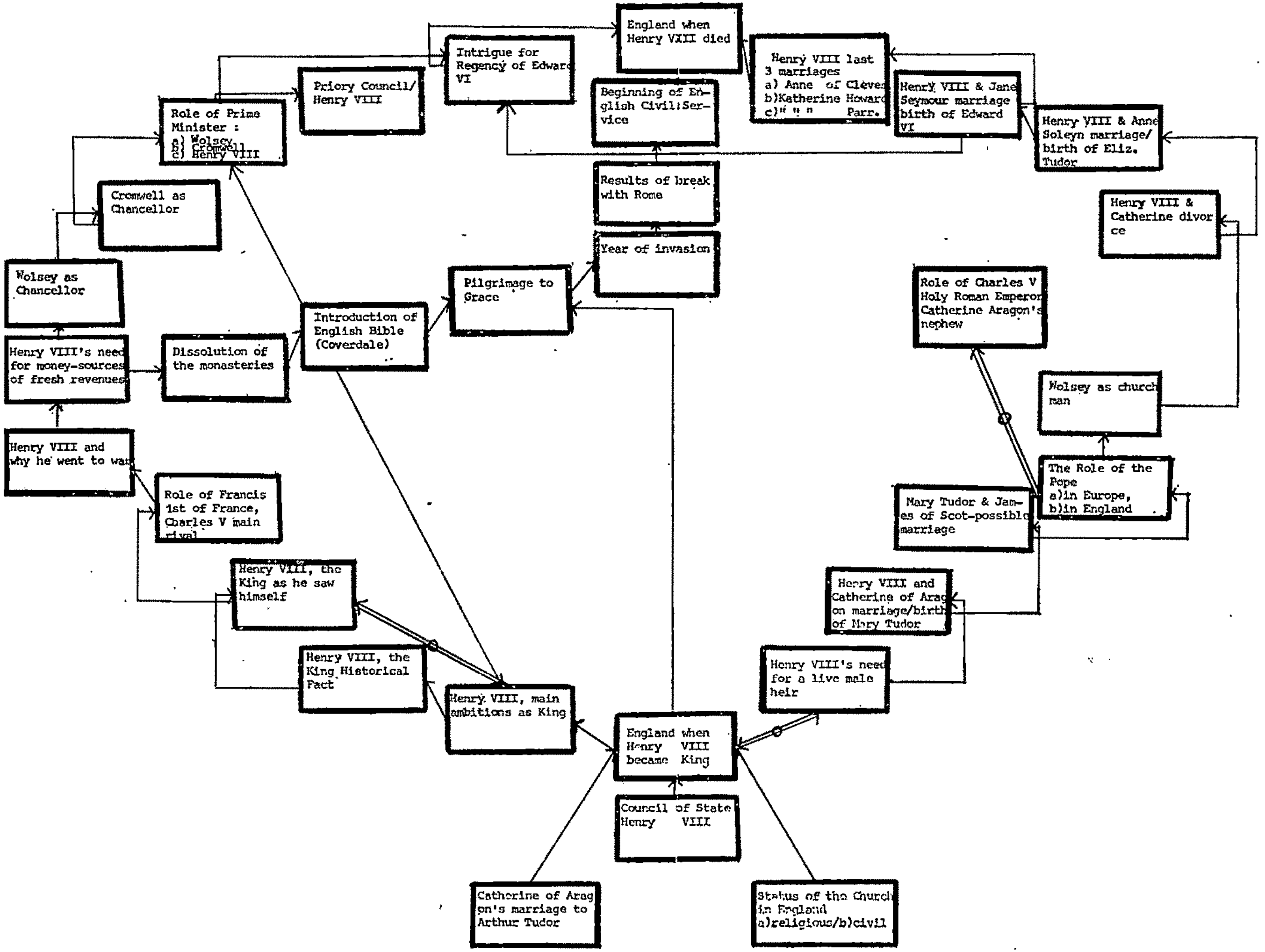

THEORY AND BEHAVIOUR OF A SIMPLE REACTION SYSTEM.
VARIATIONS OF THE EQUILIBRIUM CONSTANT WITH TEMPERATURE.
RELATION BETWEEN THE VARIATIONS OF EQUILIBRIUM CONSTANT WITH TEMP. AND VARIATION OF RATE CONSTANT WITH TEMP.
EFFECT OF TEMP. ON RATE OF REACTION.
RELATION BETWEEN ACTIVATION ENERGY H FOR A REACTION.
DETERMINATION OF REACTION ORDER FOR REACTIONS WITH MORE THAN ONE REACTANT.
DETERMINATION OF REACTION ORDER FOR REACTIONS INVOLVING A SINGLE REACTANT
CHARACTERISTICS OF THE EQUILIBRIUM STATE.
EQUILIBRIUM AND REACTION RATE.
RATE EQUATION.
LE CHATELIER'S PRINCIPLE
MOLECULAR BONDING AND OVERALL CHANGES IN REACTIONS.
REACTION RATE.
ENTHALPY CHANGE FOR A REACTION H.
PREDICTIONS OF RATE EXPRESSIONS (AND REACTION ORDERS) FROM SIMPLE COLLISION MODEL.
CONCENTRATION AND EXTENT OF REACTION.
ACTIVATION ENERGY AND BOLTZMANN DISTRIBUTION.
ACTIVATION ENERGY.
STOICHIOMETRIC EQUATION
THE BOLTZMANN DISTRIBUTION.
ELEMENTARY REACTIONS AND REACTION MECHANISM.
THE FIRST LAW OF THE THERMODYNAMICS AND CHEMICAL REACTIONS. HESS'S LAW.
MOLECULAR ENERGIES
SIMPLE CONCEPTION OF MOLECULES AND REACTIONS
TEMPERATURE.

FIGURE 2

HENRY VIII'S REIGN SEEN AS A DIALECTIC EVOLUTION, THESIS AND ANTITHESIS BEING THE POLITICS OF THE TUDOR DYNASTY AND THE PROBLEMS OF RELIGION AND DIVORCE, RESPECTIVELY


England when Henry VXII died
Intrigue for Regency of Edward VI
Henry VIII last 3 marriages a) Anne of Cleves b)Katherine Howard c)" " " Parr.
Priory Council/ Henry VIII
Beginning of English Civil Service
Henry VIII & Jane Seymour marriage birth of Edward VI
Role of Prime Minister : a) Wolsey b) Cromwell c) Henry VIII
Henry VIII & Anne Soleyn marriage/ birth of Eliz. Tudor
Results of break with Rome
Cromwell as Chancellor
Henry VIII & Catherine divorce
Year of invasion
Wolsey as Chancellor
Pilgrimage to Grace
Role of Charles V Holy Roman Emperor Catherine Aragon's nephew
Introduction of English Bible (Coverdale)
Henry VIII's need for money-sources of fresh revenues
Dissolution of the monasteries
Wolsey as churchman
Henry VIII and why he went to war
The Role of the Pope a)in Europe, b)in England
Role of Francis 1st of France, Charles V main rival
Mary Tudor & James of Scot-possible marriage
Henry VIII, the King as he saw himself
Henry VIII and Catherine of Aragon marriage/birth of Mary Tudor
Henry VIII, the King Historical Fact
Henry VIII's need for a live male heir
Henry VIII, main ambitions as King
England when Henry VIII became King
Council of State Henry VIII
Catherine of Aragon's marriage to Arthur Tudor
Status of the Church in England a)religious/b)civil

ing score is relatively higher than their comprehension learning score, the latter tending to be low ($r = 0{\cdot}77$, $N = 16$, $P < {\cdot}01$) " (Pask *et al.*, 1977, p. 71).

CONCLUSION

The series of studies recently reported by Pask represents an impressive contribution to research on realistically complex learning, but the task he has set himself is daunting.

> " Conversation theory, together with its variants and empirical realisation, is a unifying theme which allows for the integrated effort needed to make a cost effective investigation of a complex and socially important field, such as education, epistemology, learning and the regulation of attitudes and beliefs " (Pask *et al.*, 1977, p. 8).

Pask's ideas on learning are seen as more general and more directly applicable to education than Piaget's, and are, moreover, expected to apply equally well to complex topics in most subject areas. The evidence on applicability is, however, still tentative. The approach has been used in several disciplines, including history and anthropology, but it has been most successfully applied to topics in science, since the representations of knowledge required for a fixed entailment structure depend on the existence of widely agreed and clear-cut relationships between concepts and sub-topics. In the humanities and in parts of the social sciences, the relationships are necessarily contextual and relativistic. The use of individual prunings within an entailment field offers new possibilities of extending the system more effectively into these areas, but it is too soon to see clearly how this will be done.

The system originally developed in CASTE and INTUITION certainly presented a view of learning which might be seen as more acceptable to scientists than to students and teachers in other disciplines. The demand that understanding be demonstrated non-verbally with the modelling facilities may be valuable in ensuring the existence of an objective criterion, but the reliance on concrete analogies in applications to free learning situations seems unnecessary.

Pask's work has developed along two fronts. The computer-linked conversational domains have been closely associated with the development of conversation theory. The ideas on distinctive learning styles grew out of the early experiments on Clobbits and Gandlemüllers. There still seems to be a lack of correspondence between implications for education drawn from conversation theory and those which depend on the distinction between comprehension and operation learning. In the humanities, at least, the conversational domains may need to be enriched with more opportunities for non-concrete analogies than are used at present.

The bias towards ways of learning more acceptable to scientists may also have been built into the tests of learning style. These tasks depend, initially, on a taxing demand for rote learning and thereafter rely on the student finding interest in solving the problem being posed. Facility in rote learning of formulae and definitions, together with a positive reaction to solving puzzles and problems of a logical nature, are characteristics more commonly found in science than arts students. It would be important to demonstrate that correlations between different indices of learning style or strategy are equally high for students from contrasting areas of study, as well as for the same students working on different topics.

Finally, the studies so far reported rely heavily on small opportunity samples and the evaluation has been bedevilled by extraneous factors, such as time-tabling and idiosyncratic use of materials by teachers. It seems important in the next phase of research to select samples so that both subject content and age ranges are more systematically covered, and also to devise materials which are geared more directly to normal time-tabling constraints. In setting up the experiments, too, teachers will have to be persuaded that rather more experimental control must be left with the research worker, if the findings are to be really convincing to other teachers and to the scientific community.

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INDIVIDUAL AND GROUP DIFFERENCES IN STUDY PROCESSES

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SUMMARY. Study processes are postulated to intervene between classes of presage variables (personological, institutional) and product variables (academic performance). Results from several studies indicate that particular study strategies are deployed with differing success according to certain personality factors, most notably a syndrome of characteristics related to internal or external locus of control. Institutional factors that have an effect on study behaviour include Faculty membership (Arts/Science), mode of evaluation (Objective/Essay), and method of combining marks for final grade.

The interaction between personality and environmental factors as determining performance is, however, rather complex and no easy generalisations can be drawn, beyond saying that academic success is not achieved by any single study strategy; ' good ' students work effectively in quite diverse but characteristic ways. Ten dimensions of study process have evolved as sub-scales in a Study Process Questionnaire (SPQ), and they show a stable second-order structure consisting of three orthogonal dimensions: Reproducing, Internalising and Organising. Each dimension comprises a unique version of the value-motive-strategy complex. Two different models of the interaction between dimensions are postulated together with implications for future research.

THEORETICAL RATIONALE

FOR many years, student study processes have been studied in the context of an independent variable in the prediction of academic performance. Most of this work has proceeded on the simplest of nomothetic assumptions that there are ' good ' study habits and attitudes that, if adopted, would boost the performance of most students. Such work ranged from the trivial (reciting *vs.* not reciting; Gates, 1917) to the cosmic, the latter perhaps reaching its peak in Robinson's (1961) advocacy of ' the Australian crawl of study methods ', SQ3R.

Study methods can be shown to relate independently to academic performance at tertiary level (Entwistle and Wilson, 1977), but the amount of variance thus accounted for is relatively small. Lafitte (1963) found that the good student often did not waste his time on ' good ' study habits, and to complement the picture Maddox (1963) found that poor students often had the most impeccable study methods. Entwistle *et al.* (1971) conclude from their work that the common assumption that " all successful students will follow the same path to success " (p. 265) is simply false.

A more complex model is needed. Study processes—and this term is meant to include a complex of tactics, strategies and approaches that are in turn dictated by relevant values and attitudes—are conceived here as a set of variables moderating between determining factors and final academic performance. This suggestion immediately opens out a field of research in which one would look at the determinants of study behaviour, as an independent variable.

Following the Lewinian model that behaviour is an interactive function of the person and of the environment, two classes of determinants suggest themselves:

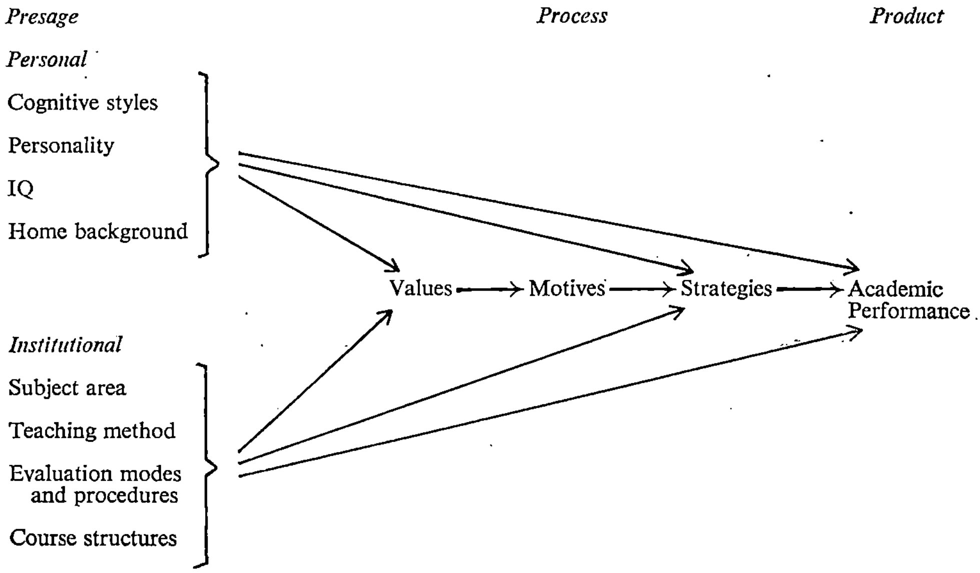
(1) Personological: e.g. personality factors, IQ, home background.
(2) Institutional: e.g. subject area studied, teaching method, evaluation mode.

Performance is then presumed to be affected by personality and environmental factors *via* the study process complex. It has been known for a long time, for example, that personality factors predict academic performance to a small but significant extent (even using the simplest univariate linear model): the present model suggests that such relationships are mediated by this complex of values and attitudes which in turn determine the processing of academic information.

The situation may be depicted as a within-the-skin variant of the presage-process-product paradigm of the classroom interaction researchers as seen in Figure 1.

FIGURE 1

General Model of Study Processes



It is thus assumed that various factors (e.g. home background, personality, impact of institution) would form values that in turn would dictate the reasons or motives the student has for undertaking further education. These motives are variously likely to determine the strategies the student uses and hence his performance; an intrinsically motivated student is suggested to go about studying in quite a different way from a student who is solely motivated by fear of failure. It is also likely that cognitive style and ability factors determine the student's level of performance both by virtue of their effect on strategies and, directly, on performance.

Three broad areas of enquiry remain:

(1) To define the study process complex, independently of the presage domain;
(2) To relate the process domain to the presage domain;
(3) To relate the process domain to performance.

Progress to date relates mainly to (1), but with some work in areas (2) and (3).

DEFINING THE PROCESS DOMAIN

It was decided at the outset to use a pencil and paper self-report questionnaire in a Likert format as a means of operationalising the study process domain; this instrument is referred to as the Study Process Questionnaire (SPQ).

The items were for the most part written as presumed operationalisations of those personality variables that a search of the literature indicated might be relevant to approaches to academic studying. For example, Hudson (1966) showed that at undergraduate levels divergently biased individuals preferred Arts, while the convergently biased opted for Science; other variables with a *prima facie* relationship to academic work included intolerance of ambiguity (Frenkel Brunswik, 1949), dogmatism (Rokeach, 1960), and cognitive complexity (Schroder *et al.*, 1967). Thus, for example, intolerance of ambiguity was operationalised, "I find it confusing when lecturers emphasise that a particular theory is only tentative and must be understood as such"; cognitive complexity, "I try to relate what I have learned in one subject to that in another"; and dogmatism, "I believe that it is useful to assume that nothing is ever certain or proved" (negative scoring). Such items, together with a general study skills set of items, e.g. "I work out in advance what my study schedule will be and then try and keep to it under all circumstances", were administered to over 300 first year students entering Monash University in 1967. The data were factor analysed and six factors extracted, roughly approximating to those intended (Biggs, 1970a). This sample also completed a battery of personality and reading performance tests, and performance data on matriculation and final performance in first year were available. These data were then intercorrelated with factor scores on the six study behaviour dimensions (Biggs, 1970b). The results were consistent with the notions that the study process items were academic manifestations of certain basic personality characteristics, and that these manifestations mediated relationships to performance. However, it was also clear that these relationships differed between the faculties of Arts and Science, and that some of the dimensions of the study process domain particularly on the issue of the relevance of value/attitude factor needed to be relabelled. Subsequent studies, referred to below, have suggested a slightly different interpretation of this or that dimension.

Presently, the SPQ has 10 unidimensional scales, as outlined in Table 1. (The first set of Cronbach alphas were computed on a 1975 Australian sample of 150 Dip. Ed. students; the second set on a Canadian sample of 148 Grade 11 students completing the HS version; Richmond, 1972.)

TABLE 1

CURRENT SPQ SCALES

1. *Pragmatism* (10 items; $\alpha = \cdot 77$; ·70): Grade-oriented; student sees university qualifications as a means to some other end.
2. *Academic motivation* (10 items; $\alpha = \cdot 69$; ·69): Intrinsically motivated; sees university study as an end in itself.
3. *Academic neuroticism* (7 items; $\alpha = \cdot 58$; ·64): Overwhelmed and confused by demands of course work.
4. *Internality* (8 items; $\alpha = \cdot 54$; ·55): Uses internal, self-determined standards of truth not external authority.
5. *Study skills* (8 items; $\alpha = \cdot 70$; ·76): Works consistently, reviews regularly, schedules work.
6. *Rote learning* (8 items; $\alpha = \cdot 70$; ·61): Centres on facts and details and rote learns them.
7. *Meaningful learning* (8 items; $\alpha = \cdot 71$; ·67): Reads widely and relates material to what is already known; oriented to understand all input material.
8. *Test anxiety* (6 items; $\alpha = \cdot 82$; ·74): Worries about tests, exams, fear of failure.
9. *Openness* (8 items; $\alpha = \cdot 63$; —): Student sees university as a place where values are questioned.
10. *Class dependence* (7 items; $\alpha = \cdot 50$; ·47): Needs class structure; rarely questions lecturers or texts.

The High School version of the SPQ, reworded to suit the school situation ('teacher' for 'lecturer', 'discussion' for 'seminar', etc.) and with the openness scale deleted, is currently being adapted for use in Australian high schools.

PRESAGE-PROCESS RELATIONSHIPS

(a) *Personological*

The original six scales were correlated with several marker variables, as reported earlier. These relationships were interpreted as indicating that stable patterns of study behaviour form the phenotypes of underlying genotypic personality variables. Of course, such an interpretation is not the only one, particularly on the basis of a correlation analysis. Another aspect to this study process style and personality relationship was indicated in another study by Biggs and Das (1973).

The point of departure in this study was the interpretation of the tendency to score extreme points on a rating scale such as a Likert item. In the 1970b study, Biggs found that those who tended to check the '1' and '5' positions on the Dogmatism scale were divergent, low on dogmatism itself, tolerant of ambiguity, intrinsically motivated, and more likely to be enrolled in Arts than Science. This finding was compatible with that of Katz *et al.* (1965) but is sharply inconsistent with the traditional interpretation of extreme scoring, which is that it indicates low intelligence, rigidity, and *in*tolerance of ambiguity (e.g. Souief, 1958; Das and Dutta, 1969).

Accordingly, Biggs and Das included some extra tests that might throw some light on this contradiction in a battery of tests to be administered to three Educational Psychology classes involved in current SPQ research. The Rokeach Dogmatism (D) scale was the instrument used to assess the adaptive kind of extreme response set (ERS), as in the earlier Biggs and Katz *et al.* studies; the Personal Friends Questionnaire (PFQ) that for determining maladaptive ERS. The latter instrument requires Likert judgments to be made to 70 adjectives desirable in a friend. In addition, ERS was assessed on the SPQ itself. All scales used a five-point Likert format.

The three ERS measures reduced to two orthogonal dimensions. The first, labelled ERS-I, was defined by ERS on the SPQ, and the D scale, and appears to reflect the intensity of the individual's beliefs about *internal* data, i.e. his reflections upon his own academic values and practices and his ideological beliefs and attitudes; while the second, labelled ERS-E and defined by the PFQ, reflects the intensity of attitudes towards *external* data, i.e. the attributes of friends. A series of correlations and analyses of variance, involving the remaining tests in the battery with the two ERS measures as dependent variables, showed that high ERS-I scorers tended to be introverted, divergent, non-dogmatic (open), to use meaningful learning strategies and to avoid rote learning. Highest ERS-I was found in those low dogmatic subjects who had high response latencies, i.e. who took their time to respond. High ERS-E subjects tended to be extroverted, dogmatic, to favour rote learning strategies, to obtain good essay ratings but low scores on an objective test requiring a high degree of inference. Highest ERS-E was found in extroverts who avoided a meaningful learning strategy. Interestingly, there were no differences between ERS-I and ERS-E in final grade for the course; no sex differences were found at any stage.

If need for certainty is the genotype underlying ERS (Damarin and Messick, 1965), it appears that the high ERS-I scorer obtains certainty by organising and integrating his ideas, the high ERS-E scorer by rote learning academic data instead of incorporating it into cognitive structure and by giving socially acceptable responses. These two pictures are strongly reminiscent either of Jensen's (1970) descriptions of Level II and Level I processes, or of Luria's simultaneous and successive processes (Das *et al.*, 1975). It was concluded that ERS "may be an index of the manner in which a person orients himself in relation to the external world"—and more to the present point—"this orientation may be predictive of his approach to academic learning tasks" (Biggs and Das, 1973; p. 208).

This study has been described at some length because it appears to tie two very important study strategies, meaningful and rote learning, to a basic genotype in personality structure concerning the life style or stance a person may adopt towards the self, other persons and the external world, that of internality-externality (Gardner and Moriarty, 1968). While this stance, as such, bears little relationship to academic performance, it is seen here that it is moderated, in a consistent way, by study process variables, which do relate to academic outcomes.

Some work has been done on home background factors (Biggs, 1972), and these will be reported briefly. A high school version of the earlier SPQ was administered to 400 boys in Melbourne sixth forms and some home background and performance data were available. Sons of Catholics, Jews and Other Non-Christians (Asians) tended to adopt meaningful learning more significantly than did C. of E., Other Christian and No Religion, and likewise for sons of fathers with primary education only. It is likely that these data reflect a relationship with low SES or immigrant parents: the schools were highly competitive, only the most academically oriented staying on to matriculation. Another finding, probably not due to selectivity, was that sons of fathers with Teachers' College certificates were outstandingly the most academically neurotic! Clearly the precise relationship between home background and study process requires further work.

(b) *Institutional*

The next set of relationships between study process variables and presage variables refers to procedures adopted in the educational institution, i.e. relating to the subject area studied, teaching method and mode of evaluation. Little work has been done so far on teaching method, but there are findings with respect to the remaining two.

(i) *Subject Area*

It seems *a priori* likely that effective study processes would differ according to the nature of the subject matter studied. One of the more obvious differences between Arts and Science subjects at first year university level is that the latter build upon a structure of knowledge that is already quite familiar, while the former are for the most part (foreign languages being a major exception) relatively unfamiliar. A further difference is that Arts material is usually more loosely structured, whereas in Science there is much less freedom for legitimate individual interpretation (at this level).

Accordingly, it was expected that prior knowledge (matriculation performance) would be the best and possibly only predictor of first year Science performance, but in Arts it was expected that the student could either rely upon a rote learning strategy, focusing upon specified course content and avoiding complexity as a Level I/successive externaliser, or he could read widely and provide his own interpretive structure, as a Level II/simultaneous internaliser. These expectations were in general borne out in the 1970a study.

These results were not however replicated in a Canadian sample (Biggs, 1976), nor by Goldman and Warren (1973) in a Californian sample of university students. In both these latter studies the same two basic strategies of meaningful and rote learning were distinguished but they were used by individuals with equal success whatever the content area. This difference could reflect differences between North American and Australian curricula, or it could refer to other institutional factors such as teaching method, or evaluation differences.

(ii) *Evaluation modes*

A major issue in the evaluation of academic performance is the extent to which different modes of testing, irrespective of reliability and validity, favour students using different study processes. There is a common belief amongst academics that they do. Adams (1964), for instance, says that "the essay stimulates use of superior study methods in preparation (but) objective tests may stimulate superficial learning of many details" (pp. 330-1). Hakstian (1971), however, concluded that students do not prepare differently for one as opposed to the other format, and that the essay does not call upon higher cognitive processes than does the objective test.

In a study on this problem (Biggs, 1973), five tests to assess course content in

Educational Psychology, were administered to two parallel classes: two objective tests, two essays, and one ambiguous (short answer), together with the SPQ. The tests were factor analysed, and very conveniently, a varimax rotation produced three orthogonal factors: general achievement (format-free), objective format and essay format. A series of analyses of variance were carried out, using the SPQ factors as independent, and factor scores on the three performance factors as the dependent, variables.

It was found that good performance was associated, whatever the means of evaluation, either with wide and integrated reading, or a 'minimax' strategy, applicable to students with a pragmatic view of the university as a means to an end, and involved rote learning all class presented material, and no other,. under conditions of self-set work schedules. Beyond that, objective tests favour convergers—so that if that was the only mode of evaluation, high convergers would end up with higher grades than low convergers—and essays favour opportunists who capitalise on perceived prejudices of the teacher. This last finding is consistent with that in the Biggs and Das study, where externalisers (equivalent to the opportunist) obtained good essay grades. One practical implication of this work is that evaluation should proceed by both formats, if the lecturer does not wish to optimise the chances either of high convergers or of opportunists.

A second issue that has been studied concerns the method of combining marks in a course to achieve a final grade (Biggs and Braun, 1972). Two common procedures are: (i) the *union* model, in which the marks from Test A, Test B, Test C etc. are added, i.e. the student has to be good at essays *and* objective *and* practicum, etc., and (ii) the *disjunction* model, in which the *best* mark is taken from Test A, Test B, etc., i.e. the student has to be good at one of several alternative things. The question is: does the use of one or other model favour a particular kind of student, in terms of his academic values or study processes? On the basis of this study, the answer was 'yes': four student characteristics uniquely discriminated the two models. The union model favours students who are class oriented and teacher-dependent, who systematically schedule private work sessions, and who rote learn significant detail but who nevertheless try to interrelate their work, while the disjunction model selects against such students.

The difference here is in 'quantity coping' strategies and makes clear sense. Remembering that both models favour relating, wide reading and academic interest, and that neurotics do poorly under both, if the lecturer wishes to favour 'quantity copers' then he should use a union model, but if he wishes to favour the 'loner' who does his own thing in depth, then he would use a disjunction model. These findings were based on habitual student study processes: the picture would likely have been clearer still if students had been warned in advance, and had opted for one or other of the models.

PROCESS-PRODUCT RELATIONSHIPS

The relationships between study process variables and academic performance have already been alluded to in the studies summarised above. Few dimensions of study process have been found to have strong main effects on performance by relating unilaterally to performance. The ubiquitous study skills dimension (scheduling private study sessions, keeping up to date with assignments, etc.) emerged most strongly in a high school population (Biggs, 1972), accounting for 10 per cent of the variance of performance scores, and in Canadian science students (Biggs, 1976) with 5 per cent of the performance variance being thus accounted for. Study skills otherwise only appeared in interaction with other variables, as already described.

Another variable which correlates consistently but negatively with performance is academic neuroticism: not surprisingly, students who feel overwhelmed and confused with course demands do poorly. There is a chicken and egg situation here, it not being clear which comes first, the confusion or the poor performance. Nevertheless this would appear to be a useful target for study improvement programmes: if this affective reaction could be reduced, academic performance might well improve. At the least, this dimension of the SPQ provides a means of identifying students actually or potentially at risk.

Further, the two meaningful and rote learning dimensions constantly reappeared as determinants of academic performance, independently of means of the mode of evaluating performance and very probably independently of the subject area being studied. Rather the determining factors as to which of the two strategies would be successfully utilised were (a) the basic personality genotype of the student, i.e. internal or external, and (b) the not unrelated question of his academic values, i.e. whether he sees university as a means to another end, or as an end in itself.

In short, then, the question of process-product relationships is not a simple one. Certainly there is little evidence to support optimistic generalisations about the 'best' methods of studying, whether SQ3R or anything else.

FOCUSING THE STUDY PROCESS DOMAIN

The previous research has generally supported the hypothesis that study processes mediate between personality factors and academic performance in sometimes quite complicated ways; the domain itself is construed in terms of 10 separate dimensions. A more economical way of handling the situation would clearly be desirable, particularly in view of the desirability of using study processes in aptitude-treatment situations.

There appear to be two ways of handling the situation, each with rather different assumptions about the interaction between person and environment. The first way assumes that there are personality characteristics of wide generality and stability; psychometrically this is identical with R-analysis (Cattell, 1966), which proceeds by postulating unidimensional traits across populations. The second way assumes that people may act consistently *within*, but not between, situations; psychometrically this is identical with Q-analysis, which proceeds by defining criterial situations and finding consistencies across people to fit the situations.

To date, the research has been proceeding in traditional, R-analysis, terms. In deriving the scales, a hopefully random sample of the total population is tested; i.e. Arts, Science, males, females, internals, externals, introverts, extroverts, high ability, low ability students, etc., are thrown together, and if these all agree that certain items go together, then eigen values exceed unity, a factor emerges, and a scale is born. Particularly if that scale is replicated several times, then one concludes that this dimension is an important one in the study process domain.

This is certainly all in accord with established practice, but it is possible that this unidimensionalising over a diverse population, or R-analysis, might just be masking the very things that one is interested in. Perhaps, in view of the supposed interactions and causal sequences involving personality variables, academic values and attitudes and study strategies, one should be working *within*, not across, domains, because in the latter it is possible that R-analysis techniques tend to ' homogenise out ' those very interactions and sequences that one is seeking. The same would apply to other presage domains, such as institutional ones, e.g. enrolment in an Arts or Science course.

Q-analysis

Q-analysis thus presents itself as an alternative technique. Instead of pooling people and finding consistencies among their responses, as in R-analysis, people and responses are transposed: each item is tagged with its ‘ response ’, i.e. a person with known characteristics (e.g. science, male, high ability), and then the whole matrix is factor analysed to see if the people form consistencies, i.e. the analogue of scales. This procedure was adopted in Biggs (1976), in which the specific hypothesis was tested, using an oblique Procrustes model, so that the items would consistently group people to form three factors: general achievement whatever faculty orientation, Arts-unique and Science-unique. This hypothesis was confirmed: the general factor pattern was the first to emerge and the clearest, although faculty specific patterns also existed. The loadings did not differ materially between males and females. This suggested that the SPQ items most easily ordered into an internally consistent complex that applied to achievement whatever the subject matter studied, and independently of sex.

The next question is to look at the constitution of this complex. Each item's factor score on the three factors was computed, and those with factor scores exceeding ±1·3 sigma were identified. It was thus possible to see what kinds of items went together when the specific aim was to distinguish general achievement from faculty-specific achievement.

Q1 comprised 12 items: 6 study skills, 3 neuroticism (negative), 1 test anxiety (negative), 1 internality (negative) and 1 academic motivation. This complex suggests a well-organised, externally oriented student with low anxiety; the target was overall high achievement.

Q2 comprised 15 items: 5 pragmatism (negative), 3 study skills (negative), 3 openness, 2 internality and 2 meaningful learning. This complex arose when Arts membership was the target: it suggests the non-pragmatic, disorganised Arts student, with an open value system, an internal stance and meaningful learning based upon wide reading.

Q3 comprised 11 items: 3 pragmatism, 3 academic motivation (negative), 1 external, 2 study skills, 1 rote learning and 1 meaningful (negative). The target here was Science membership; the resulting complex indicates an ambitious opportunist who minimises his workload and rote learns within that.

These three ‘ types ’ were constructed specifically to predict cross-faculty and inter-faculty achievement, and the question was whether they predict performance better than the R-scales. A series of stepwise regressions was run and this analysis is reported in Table 2.

It can be seen that High School Matriculation scores predicted best in all faculties, more so in Science than in Arts; and that Q1 and Q2 both contribute significantly to R^2, except in Arts females, where prediction is not improved by using any of the SPQ scales. Interestingly, however, Q2, originally contrived to fit Arts membership, is seen to predict significantly and positively in both Arts males, and Science males and

TABLE 2

STEPWISE REGRESSION OF HIGH SCHOOL (HS) AND Q-SCALES, ON GPA ($P<{\cdot}05$)

	Arts				Science			
	Male		Female		Male		Female	
Step.	Pred.	Cum. %	Pred.	Cum. %	Pred.	Cum. %	Pred.	Cum. %
1	HS	23·9	HS	32·1	HS	48·2	HS	60·1
2	+Q1	28·6	—	32·1	+Q1	54·6	+Q1	68·0
3	+Q2	32·0	—	32·1	+Q2	56·3	+Q2	70·7

females. The so-called science Q-scale does not appear at all. The Q-scales are clearly misnamed, despite their construction: they refer to two effective general complexes, which seem to comprise the values, attitudes and strategies appropriate to the general internal and external stances referred to earlier, and which are appropriate to performance in either faculty. By way of comparison, virtually the same amount of variance was accounted for by five R-scales, as opposed to two Q-scales (Biggs, 1976). Thus even when a deliberate attempt to accommodate to faculty specific study processes was made, the resulting scales predicted performance equally well whatever the faculty.

This finding could be interpreted to mean that the original R-analysis assumptions are appropriate after all; i.e. that there are general, cross-situational study processes. The original 10 R-scales themselves were obtained by an oblique solution, and intercorrelation is present. Both generality and parsimony would therefore indicate further R-analysis; accordingly, several higher order factor analyses were carried out.

Higher order factor analysis

The 10 R-scales were factored to an orthogonal solution (principal components with varimax rotation) in three separate samples: 420 Canadian university freshmen enrolled in English and Chemistry classes, the questionnaires being administered by post and completed voluntarily; 150 Australian university students in their Diploma in Education year, the questionnaires being administered during regular class hours; and a different group of 148 Dip. Ed. students, the questionnaires being picked up and completed returned on a totally voluntary basis. The results of the analyses are reproduced in Table 3.

TABLE 3

SECOND ORDER FACTOR ANALYSIS (VARIMAX ROTATION) OF 10 R-SCALES IN THREE SEPARATE SAMPLES

Study Process Scales	Sample 1			Sample 2			Sample 3		
	I	II	III	I	II	III	I	II	III
Pragmatism	*75*	-04	04	*73*	06	15	*77*	-17	09
Ac. Motivation	-05	*44*	*70*	-14	*80*	29	-10	*53*	*69*
Neuroticism	*56*	16	*-60*	*64*	-05	-28	*59*	17	*-44*
Internality	06	*78*	08	-03	*82*	-10	06	*74*	28
Study Skills	30	-01	*82*	08	14	*94*	38	-05	*76*
Fact-Rote	*78*	-16	09	*85*	-09	19	*74*	-35	13
Meaning	07	*61*	06	15	*77*	20	02	*40*	*65*
Test Anxiety	*68*	18	-13	*65*	32	*-45*	*71*	17	08
Openness	04	*72*	-02	07	*67*	11	03	*84*	02
Class Dependence	*70*	-08	06	*76*	01	00	*70*	08	01
% Variance	25	18	18	27	25	14	27	19	18
Total			62			66			63

Sample 1: Canadian University Freshmen. N=420. Voluntary administration.
Sample 2: Australian University Dip. Ed. students. N=150. Class administration.
Sample 3: Australian University Dip. Ed. students. N=148. Voluntary administration.

It can be seen that the three factor solution is virtually identical across the three different samples. This is rather surprising, considering the different levels of student tested, subject areas, countries and conditions of administration. The first factor (from 25 per cent to 27 per cent of total variance in the three samples) is defined by the same scales with virtually the same loadings: fact-rote, pragmatism, test anxiety, neuroticism and class dependence. The second factor (from 18 per cent to 25 per cent of total variance in the three samples) is also defined by the same tests, although there is more difference here in the size of the loadings across samples: academic motivation, internality, meaningful learning, and openness. The third factor (from 14 per cent to 18 per cent of total variance in the three samples) showed more variation, with study skills being the highest loading scale in all three cases and associated with low anxiety (negative loadings of either neuroticism or test anxiety) in all three cases, and academic motivation in two cases and meaning in one.

The interpretation of the factors was helped by correlating the original 80 items with the three second order factor scores. It became clear that items on each factor grouped themselves in line with the value-motive-strategy structure postulated in the study process complex in Figure 1; i.e. a group of items in each factor addressed values, another group motives, and a third group cognitive strategy, as follows:

1. *Reproducing*. Value: study as a means to end (pragmatism), hence, motive: fear of failure (neuroticism, test anxiety), in turn dictating minimax strategies (class dependence, rote learning). The person sees the university as an instrument, a means to an end. His motives for studying are then governed by the fear of not achieving that end, so he defines his goals minimally compatible with success, and uses the simplest strategy of learning, i.e. reproducing what he is supposed to do and no more.

2. *Internalising*. Value: self growth, actualisation. The university is seen as the place wherein the self actualisation process can take place; the motive is intrinsic, studying is a process of growing (if it weren't for that individual he would drop out) and hence wide reading, interrelating, and meaningful learning strategies. Growth only takes place if the material is internalised and related to existing knowledge.

3. *Organising*. There are holes in the specific details here but extrapolating from the value-motive-strategy complex the picture makes a psychologically meaningful one. The value here is competing and winning, whether the goals are self-set or not. This leads directly (Atkinson, 1966) to n-Achievement as the motive. Items comprising the R-scale Academic Motivation included academic motivation in the sense of intrinsic motivation, e.g. " I become increasingly absorbed in my work the more I do "; and also in terms of n-Achievement, e.g. " I have a strong desire to excel in all my studies ". The former defined the ' Motivation ' loading on Factor 2; the latter that on Factor 3. Successfully to operate on the basis of the ' killer instinct ' requires a very cool, low anxiety, highly organised approach to work. This is the syndrome that clearly emerges on Factor 3.

These relationships are summarised in Table 4.

Aspects of these second order dimensions strongly recall the work of others. Entwistle (Entwistle and Brennan, 1971; Entwistle and Wilson, 1977) has used cluster analysis to pick out types of students into high attaining and low attaining groups. The score profiles of the first three groups of high attainers were:

1. *Highly motivated stable scientists*. High A-levels, highly motivated, good study methods, tough-minded conservatism: ". . . a rather cold and ruthless individual, governed by rationality and spurred on by competition . . . (Entwistle and Wilson, 1977, p. 129).

2. *Hardworking syllabus-free arts students*. Good verbal ability, high motivation, good study methods, long study hours but syllabus-free (e.g. " I tend to learn more effectively by studying along my own lines than through doing set work "), high aesthetic interests and radical attitudes.

3. *Anxious students who work long hours*. High neuroticism, high syllabus-boundedness, low motivation: ". . . it is tempting to see these students as motivated mainly by ' fear of failure '. . ." (op. cit., p. 130).

Given that different scales and theoretical constructs were used, these clusters, or

TABLE 4

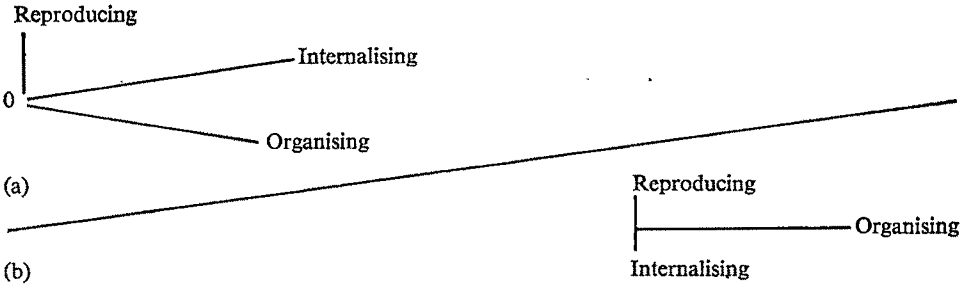
THREE ORTHOGONAL VALUE-MOTIVE-STRATEGY DIMENSIONS

	Value	Motive	Strategy
Factor 1 (Reproducing)	Pragmatism: instrumental values, university is means to another end.	Test Anxiety, Neuroticism: motive to study is fear of failing.	Class Dependence, Fact-Rote. Minimax: goals are those defined in the course, no more; rote learned to a reproductive criterion.
Factor II (Internalising)	Openness, Internality: Self-growth or actualisation seen as overall goal, university permits this.	Academic Motivation: intrinsic, what contributes to growth is interesting, self motivated.	Meaning: work unsatisfying unless understood and incorporated with existing knowledge. Class only *basis* for stimulation.
Factor III (Organising)	Winning through competition: university a game to show excellence.	Achievement motivation: need for success, low anxiety.	Structuring, organising work, meets deadlines, plays the game.

types, bear a striking resemblance (*a*) to high scorers on each of the second order factors Organising, Internalising and Reproducing respectively; and (*b*) to the Q-scale descriptions Q1 and Q2 respectively (Q3 overlaps these and others of Entwistle's clusters). Cluster analysis is a purely descriptive technique: it says little about interrelationships between the variables nominated or about the combinations that are *not* nominated. If, however, the clusters are seen as mappings within a three-dimensional space (op. cit., pp. 123-5), then the present second order factors would appear to serve remarkably aptly as the three axes concerned (see Figure 2 (a)).

FIGURE 2

ALTERNATIVE MODELS OF STUDY PROCESS DIMENSIONS



In Figure 2 (a) an individual can be mapped on all three dimensions independently of his position on any one. This leads to the perhaps unlikely situation where a person could be high on Organising, Internalising and Reproducing: this is unlikely, not because of any incompatibility in alternating cognitive strategies, but in maintaining different value systems.

Other writers maintain a two-factor rather than a three-factor system: e.g. Level I and Level II processes (Jensen, 1970) or simultaneous and successive processing (Das, *et al.*, 1976) which would lead to two-factor study process domain based largely upon rote and meaningful learning; ' deep level ' and ' surface level ' processing (Marton, 1975) or internalised and externalised study strategies (Biggs and Das, 1973). Figure 2 (b) suggested a model that is compatible with an essentially two-factor solution: the exclusiveness is between reproducing and internalising, but either may also involve degrees of the killer instinct and ensuing strategies. Further empirical work is required to elucidate which might be the more explanatory model.

IMPLICATIONS AND FURTHER WORK

There are several implications of the model presented above.

(1) *Instrumentation*

The model suggests a 3 × 3 scale score structure instead of the present SPQ which yields 10 separate conceptually unrelated scores (as do other inventories). Thus, each factor would contain subscores for each value, motive and strategy, enabling either a total score for, e.g. Reproducing, or subscores for each of pragmatism, test anxiety (fear of failure) and rote learning. Work is in progress constructing and evaluating such an instrument.

(2) *Improvement of study process*

Prediction of academic performance has received a great deal of attention (Entwistle and Wilson, 1977), and has been rather discouraging. The above model suggests a different, *congruence*, approach to the problem. The present data have shown that most students tend to respond to items from the value, motive and strategy domains so that certain values, motives and strategies happen to go together (at least in so far as a stable second order structure emerges). Further, there is evidence—intuitive, and Entwistle's high attaining clusters—to suggest that the observed complexes are *adaptive* ones.

It is then possible that certain cases of underachievement might be traceable to value-motive-strategy mismatch; e.g. a pragmatist who tries to read widely and integrate his work. Empirically one would hope to show that high achievement occurred for congruent or matched complexes, low achievement in cases of mismatch.

In that event, the target for change, e.g. in counselling, would involve congruence; so that the student could accept some aspects of his functioning as they are, but that others need changing. ' Study method ' courses are usually based on organising, but is that of any avail to a student lacking high n-Achievement and thus the ruthless kind of motivation necessary for the success of the organising strategy? Counsellors, and more particularly academics, would be loth to recommend minimax reproductive strategies, yet to the student who is afraid of failing such an anxiety-allaying strategy is very probably just what he needs.

(3) *Aptitude-treatment interaction*

The reduction of a complex domain to three process dimensions of high generality raises the possibility that those dimensions could be useful in ATI. Little work on this has been done to date. One unpublished study by Biggs suggests that students who obtained high scores in a lecture format scored significantly high on Reproducing, while those who attended both lectures and individualised tape-cassette-workbook versions scored high on Internalising.

Further extensions within this general area are limitless; as Figure 1 suggests, that there are many institutional ' treatment ' variables, and if the three factors described here do represent the more important stable and generalisable aptitudes in the study process domain, then the presence of ATI should be investigated. Where it was established it might be feasible to advise students on options where different treatments of the same course are available on the basis of their SPQ scores and/or sub scores.

In sum, the accumulation of research over several years is pointing to an at least three-dimensional model of the study process domain, incorporating a complex of values, motives and strategies with its own psycho-logic. This complex mediates between personological and environmental or treatment variables on the one hand and academic performance on the other. Many important aspects of the model obviously require further research, but it is suggested that this kind of model might be a fruitful guide to teachers, counsellors and students in controlling learning processes in the tertiary academic domain.

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SIX REACTIONS TO SCHOOL TRANSFER

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SUMMARY. Two samples representing rural (N = 390) and city (N = 454) children were tested before and after transferring to secondary school in an attempt to determine the nature of individual reactions to school transfer. Measures used included ability, achievement, attitude to school, and personality. Cluster analysis applied independently to these two samples identified six subgroups showing different patterns of adjustment. Two of these reactions were considered particularly important. One, labelled disenchanted, characterised able children showing poor adjustment and academic deterioration. The other, described as worried, associated low ability with high anxiety, and poor self-concept. Since the six reactions were replicated across both samples it is suggested that they comprise widely occurring reactions to school transfer.

INTRODUCTION

FEW children escape transferring from one school to another and consequently school transfer must be considered a standard feature of education. Whether or not it constitutes a problem is less certain. In that for most children school transfer occurs around the age of 11 in England, at the transition from primary to secondary education, it seems likely that the rapid intellectual and personal development associated with that age might be affected by the new environment. However, whilst one opinion says that this effect is detrimental (e.g. Doe, 1976) the opposing one contends that the novel situation fosters development by providing extra stimulation (Plowden, 1967). In practice neither view will be entirely satisfactory, simply because of the wide variability between individual children.

Most research into primary/secondary transfer has tended to examine its structure as represented by transfer arrangements (Dutch and McCall, 1974; Neal, 1975), age of transfer (Nisbet and Entwistle, 1966) or assessment procedures (Sumner and Bradley, 1977). Of the studies that have centred upon the children's reactions, the majority have investigated rather specialised problems such as grammar school failure (Dale and Griffith, 1965) or the progress of maladjusted pupils (Pumfrey and Ward, 1977). Consequently the general problem of adjustment after transfer has to be assessed from a limited range of studies such as that by Nisbet and Entwistle (1969) or from incidental findings in the researches already mentioned.

Nisbet and Entwistle's (1969) investigation, together with its follow-up (Nisbet *et al.*, 1972), is probably the most comprehensive account currently available. They showed that from a range of intellectual, personal and social determinants of school attainment, prior performance was the most powerful single predictor. Not only were the effects of other factors substantially weaker, but they also had differential influences, since non-intellectual factors operated more strongly for boys than for girls. Over all, though, the effect of non-intellectual factors was still sufficiently important for them to conclude that ' in primary and secondary motivation, aspiration and emotional stability are closely related to attainment ' (Nisbet and Entwistle, 1969). In extending this analysis to progress, they found that for boys improvement was associated with high academic motivation, a positive attitude to work and strong parental encouragement. For girls a similar pattern obtained, with the addition of stability and social maturity. Dale and Griffiths' (1965) grammar school study also showed that deterioration was most pronounced with less able pupils. A project by Birmingham's Educational Development Centre (Neal, 1975) included case studies of children showing poor or positive adjustment to secondary school. The poorly adjusted children often appeared unforthcoming, having feelings of rejection. Some of the positively adjusted children were described as apprehensive. Unfortunately no more objective information was collected during this potentially valuable part of the study.

From this limited account it is clear that ability is seen as the major determinant of achievement in the secondary school. Other aspects of adjustment, such as effort and absence of anxiety, have received less attention but again they tend to be associated with a general academic ability factor. How far is it possible to break down this picture to take into account individual reactions to school transfer? The following analysis is part of a large study of transfer from primary to secondary schooling carried out jointly by Nottinghamshire Education Committee and the University of Nottingham, School of Education (Youngman and Lunzer, 1977). Two samples comprising the intakes to three rural and three city schools were assessed on a selection of intellectual, personality, self-concept and attitude measures, before and after transfer.

METHOD

Procedure

The complete intakes to three rural comprehensive schools were tested in May before transferring to the secondary school the following September. These assessments covered non-verbal reasoning, achievement in mathematics and reading, academic motivation, self-concept and attitude to school transfer. After two terms in the secondary school the children were re-tested on the motivation and self-concept scales, and on a modified form of the attitude scale. Achievement testing was delayed until the end of the second year in secondary school. A comparable city sample was obtained and assessed in a similar fashion but one year behind the rural sample. Subsequent analyses of the relationships between the various child characteristics were performed separately on the two samples. This enabled consistent patterns to be identified, and also any specific differences between the two types of intake to be examined.

Samples

Rural Sample. Transfers to schools other than the three target comprehensives meant that more primary children were tested than were subsequently included in the analyses. The main analysis sample, comprising those tested in their first year of secondary schooling, totalled 390 children (211 boys, 179 girls). Subsequent school changes and absenteeism meant that the sample tested after the second year on the achievement measures totalled 290 children (146 boys, 144 girls). The schools were all comprehensive, two of them having been purpose-built, including separate lower school units. Their contributions to the sample size were 151, 158 and 81 children, the first one being the one that developed from a secondary modern school.

City Sample. The equivalent sample sizes for the city schools were 454 children (232 boys, 222 girls) initially and 359 children (183 boys, 176 girls) on final testing. The three city schools were all comprehensive and their intakes spanned communities ranging from a large between-wars council estate to a new and still growing private housing development. Sample contributions were 148, 147 and 159 children for the three schools. None of them had a lower school unit.

Measures

It is not possible here to give full accounts of all the measures used; further details, particularly the forms of the specially designed attitude and self-concept scales, are available in the main project report (Youngman and Lunzer, 1977). Brief outlines of the measures, including Cronbach's alpha reliability estimates (Cronbach, 1951) follow.

Biographic Data. Primary school, secondary school, age, sex and social class were the five biographic items sought, but because of reluctance on the part of some of the participatory schools, the final item was not pursued.

Attitude to School. Two scales were designed to assess reactions to transfer beforehand and afterwards. Oblique factor analysis (Kaiser and Rice, 1974) generated three factors each time. They comprised the following sub-scales:

Variable	*Description*	*No. of items*	*alpha*
6	Junior attitude to secondary school	11	·75
7	Junior attitude to primary school	11	·81
8	Junior apprehension over transfer	12	·78
13	Secondary attitude to secondary school	10	·75
14	Secondary attitude to primary school	5	·70
15	Secondary anxiety	9	·75

Personal Adjustment. Oblique factor analysis of a self-concept in school inventory produced three sub-scales. The same inventory was administered at primary and secondary level. Academic motivation was assessed on both occasions using Entwistle's Aberdeen Academic Motivation Inventory (Entwistle, 1968).

Variable	*Description*	*No. of items*	*alpha*
9	Junior self-concept: social	6	·65
10	Junior self-concept: personal	7	·62
11	Junior self-concept: academic	6	·57
12	Junior academic motivation	24	·68
16	Secondary self-concept: social	6	·66
17	Secondary self-concept: personal	7	·52
18	Secondary self-concept: academic	6	·58
19	Secondary academic motivation	24	·72

Ability and Achievement. Non-verbal reasoning was tested once using the NFER Test BD (Pidgeon, 1965) in the May before transfer. Achievement in mathematics was assessed by means of the NFER Test DE (NFER, 1974), a standardised measure of general mathematical understanding. For reading comprehension at the primary level the Gap Reading Test (McLeod, 1970) was used but a more advanced test was needed at secondary stage. With the rural sample the Edinburgh Reading Test (McBride and McNaught, 1973) was applied whilst a test developed at Nottingham by Mr. M. Waite (Lunzer and Gardner, 1977) was administered to the city sample. The Waite test is a reading comprehension test consisting of a series of questions on a longish prose passage.

Variable	*Description*
20	Junior non-verbal reasoning (standardised)
21	Junior reading comprehension (raw)
22	Junior mathematics (standardised)
23	Secondary reading comprehension (raw)
24	Secondary mathematics (standardised)

RESULTS

Characteristics of the two samples

Table 1 shows the mean score on each measure for both samples, allowing similarities and differences between them to be identified. The most obvious difference is in ability, since the rural sample excels on all five comparable intellectual measures. The other differences are associated with this intellectual superiority; the more able rural sample records higher junior academic self-concept scores, less secondary

TABLE 1

BASIC STATISTICS FOR THE RURAL AND CITY SAMPLES

Variables	Rural Sample N=290			City Sample N=359	
	Mean	SD		Mean	SD
6 Junior attitude to secondary school	18·58	4·59	x	9·04	2·16
7 Junior attitude to primary school	16·57	4·87	x	8·27	2·62
8 Junior apprehension	11·24	6·22	x	6·19	2·98
9 Junior self-concept: social	7·81	2·71		7·44	2·48
10 Junior self-concept: personal	9·91	2·79	**	10·47	2·61
11 Junior self-concept: academic	7·12	2·55	**	6·59	2·29
12 Junior academic motivation	14·99	3·67		15·33	3·56
13 Secondary attitude to secondary school	29·72	4·70		29·58	4·31
14 Secondary attitude to primary school	11·28	3·44	**	12·06	3·10
15 Secondary anxiety	20·25	4·54	**	21·55	4·28
16 Secondary self-concept: social	7·68	2·61		7·72	2·28
17 Secondary self-concept: personal	9·86	2·11		9·51	2·35
18 Secondary self-concept: academic	6·79	1·86		6·67	1·89
19 Secondary academic motivation	15·79	4·01		15·92	3·77
20 Junior non-verbal reasoning	97·54	13·45	**	93·06	12·96
21 Junior reading comprehension	28·29	6·65	**	23·89	7·66
22 Junior mathematics	98·59	12·49	**	90·56	10·40
23 Secondary reading comprehension	111·61	32·38	x	62·86	17·13
24 Secondary mathematics	98·29	12·96	**	95·50	12·75

x=characteristics measured differently on the two samples.
**=P<·01, based on t-test for difference between the sample means.

anxiety and lower scores on secondary attitude to primary. The only measure which runs against this pattern is junior self-concept personal where the city sample scores higher. The overall picture presented by these differences is consistent, with the rural sample generally more able. This should facilitate the interpretation of later analyses.

Particular relationships

The overall pattern of relationships between many characteristics is usually examined by means of the correlation coefficient, or one of its derivatives such as factor analysis or multiple regression. Both these analyses were applied (Youngman and Lunzer, 1977) but the present section attempts to summarise the multiple relationships by providing a more individualistic analysis of score profiles. The appropriate statistical technique is cluster analysis. The version applied, Wishart's relocation method (Wishart, 1969), is described in detail in Anderberg (1973) or Youngman (1976). In principle the method compares the score profiles of individuals and random groups and gradually forms clusters of children with similar score patterns. The successive fusing inherent in Wishart's relocation method results in progressively fewer clusters in each classification. In this instance the seven-cluster solution was accepted as the one which maximised group homogeneity whilst producing a suitably small number of interpretable groups.

Like most multivariate methods, the outcome can be heavily dependent on the sample used. To protect against this danger the rural and city samples were analysed separately. By comparing the seven clusters produced by each analysis it was possible to assess the degree to which comparable groups appeared. In fact six of the seven groups were replicated in the two samples. As a result one can be more confident that the six reactions to transfer implicit in these groups are likely to arise in a wide range of populations, particularly in view of the marked intellectual differences between the two samples.

Clusters are usually characterised by their profiles of average scores and these are given in Table 2. However, in this particular analysis it is especially important to consider any changes in score levels on variables measured before and after transfer. Similarly, interpretation of the cluster profiles should include a comparison of the two analyses. Figures 1 and 2 are modifications of Table 2 designed to facilitate interpretation in these two areas.

The six groups split neatly into three high ability types and three with below average ability. Figure 1 shows the average scores of each high ability type, the levels being plotted relative to the overall means of the measures (see Table 1). The maximum extension above or below the mean for each measure is one standard deviation. The

TABLE 2

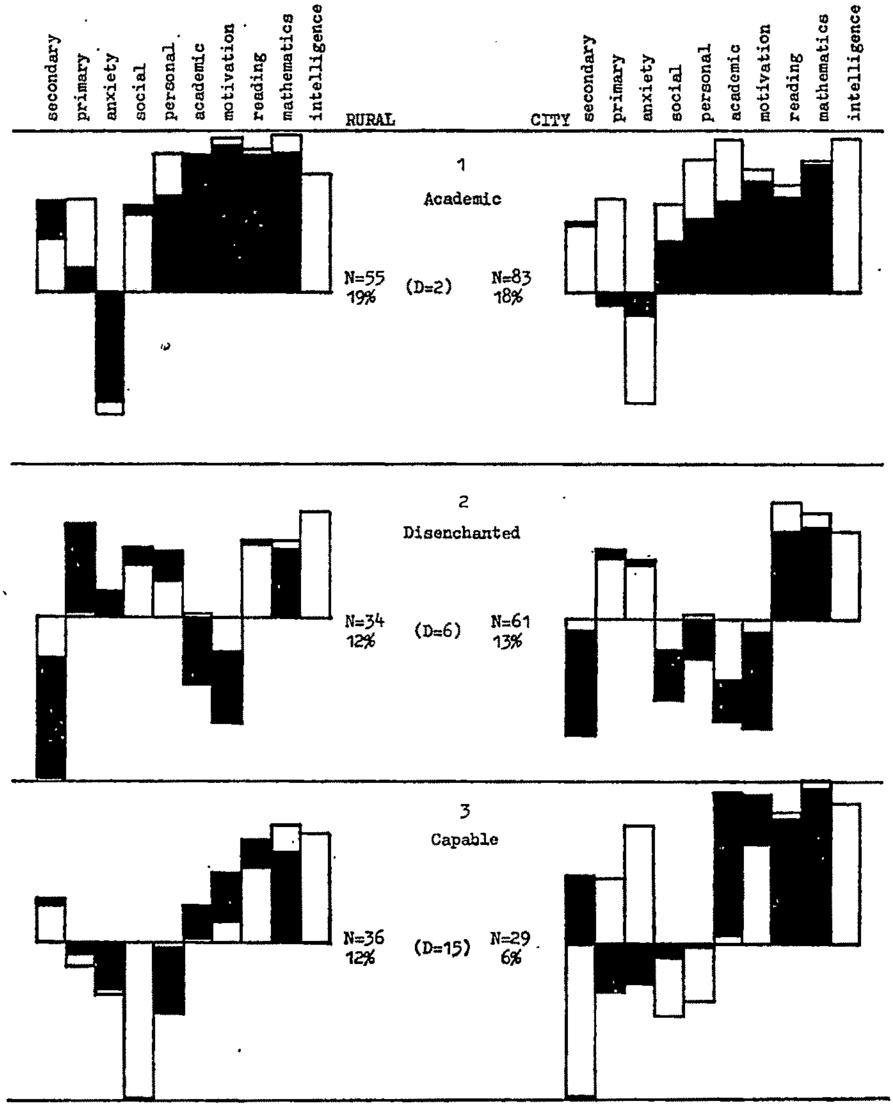
CENTROID SCORES FOR THE SIX CLUSTERS OF BOTH SAMPLES

		High Ability Clusters			Low Ability Clusters		
Variables		1	2	3	4	5	6
6	Junior attitude to secondary school	20·04	17·41	19·58	20·53	18·82	19·32 *
		9·88	8·85	4·93	10·07	9·52	7·89
7	Junior attitude to primary school	19·33	16·62	15·92	17·59	15·15	17·18 *
		9·61	9·21	9·28	8·05	9·09	8·52
8	Junior apprehension	6·56	12·29	9·28	9·97	11·67	17·53 *
		4·27	7·05	7·97	5·76	6·66	9·02
9	Junior self-concept: social	9·09	8·71	5·19	9·60	7·74	5·79
		8·70	6·75	6·14	8·03	8·46	6·31
10	Junior self-concept: personal	12·26	10·56	9·86	11·00	8·80	7·85
		12·64	10·41	9·76	10·93	11·08	8·05
11	Junior self-concept: academic	9·26	7·15	7·14	8·43	5·64	4·88
		8·71	5·82	6·55	6·56	7·33	4·75
12	Junior academic motivation	18·46	14·23	15·47	16·14	13·26	13·03
		17·96	14·87	17·31	16·17	15·47	13·66
13	Secondary attitude to secondary school	32·36	24·91	31·00	31·74	29·10	30·77
		31·71	26·43	31·14	33·95	28·57	27·86
14	Secondary attitude to primary school	11·73	13·27	11·08	10·03	11·21	9·56
		11·89	13·44	11·27	9·44	13·73	12·12
15	Secondary anxiety	17·18	21·03	18·89	19·76	20·36	24·24
		20·95	23·12	20·45	18·17	23·10	23·99
16	Secondary self-concept: social	9·07	8·79	5·11	9·24	8·49	5·06
		8·43	6·64	7·59	8·90	8·42	7·19
17	Secondary self-concept: personal	11·09	10·71	8·94	10·90	9·90	7·47
		10·53	8·93	9·38	11·00	9·56	7·79
18	Secondary self-concept: academic	8·35	6·03	7·19	7·29	6·05	5·35
		7·71	5·62	8·38	7·92	6·44	5·23
19	Secondary academic motivation	19·40	13·21	17·50	17·24	12·67	14·09
		18·40	13·34	19·28	18·42	15·31	14·52
20	Junior non-verbal reasoning	107·18	106·44	106·64	93·83	82·80	90·35
		105·80	100·12	104·07	87·46	83·55	82·00
21	Junior reading comprehension	34·15	31·32	31·44	27·40	20·28	25·59
		29·10	29·53	30·17	22·81	19·44	17·12
22	Junior mathematics	110·58	104·56	107·44	96·60	84·15	91·21
		99·10	96·97	100·62	88·32	83·18	80·65
23	Secondary reading comprehension	138·82	127·00	132·33	109·53	75·39	88·38 *
		99·11	97·26	101·78	88·78	83·00	80·84
24	Secondary mathematics	109·22	104·21	109·39	94·10	86·00	90·29
		106·00	102·29	107·57	93·22	87·85	84·30
	Cluster Sizes Rural	55	34	36	58	39	34
	City	83	61	29	59	77	65

Note: For each variable the top row gives the rural sample means, the bottom the city.
* = variables measured differently on the two samples (not comparable).

FIGURE 1

THE THREE HIGH-ABILITY REACTIONS



Notes: 1. Header variables are ordered as in Table 1.
2. Group averages are plotted relative to the overall mean for the measure.
3. The maximum extension either side of the mean is one standard deviation.
4. White blocks indicate primary school levels, black secondary.
5. The D statistic is the distance between the equivalent rural and city groups.

white blocks refer to the primary score level, the black to secondary. Where only a black block appears (for example, academic self-concept of rural type 1) both primary and secondary scores are at the same level. The D statistic gives an indication of the difference between the equivalent rural and city sample clusters, the formula for D being:

$$D_{A,B} = \frac{2\,ab}{M(a+b)} \sum_{i=1}^{M} (U_{A_i} - U_{B_i})$$

Where

A, B are the two clusters being compared

a, b are the cluster sizes

M is the number of measures in the profile (i.e. 19)

U_{A_i} is the average score for group A on measure i

Interpretation of D depends on all these constituents, but a useful rule of thumb can be obtained by dividing D by the average size of the two groups, and then taking the square root. If the data are standardised, as the above were, the resultant figure is the average difference between the groups in terms of standard deviations. So for type 2, the average group size is approximately 48.

$$\frac{D}{48} = \frac{6}{48} = \frac{1}{8} \qquad \text{square root} \doteqdot \frac{1}{3}$$

This implies that the difference between the two groups averages out at about a third of a standard deviation for each measure.

Three High Ability Reactions

1. *Academic.* The two academic profiles are very similar as can easily be seen from their shapes. The group's characteristics fit the traditional academic pattern of high ability, performance, motivation and self-concept, and low anxiety. In both samples this reaction covers 20 per cent of the overall sample, and has an equal proportion of boys and girls.

2. *Disenchanted.* Although the difference between these two groups is slightly larger, agreement is very close on the defining characteristics. These are low secondary attitude to secondary school, academic self-concept and motivation allied with moderately high academic performance. Anxiety scores are average. The groups both comprise around 12 per cent of each sample, but there is a difference in the proportion of boys; 53 per cent for the rural sample but only 31 per cent for the city.

3. *Capable.* This group shows worst replicability across the two samples and consequently the interpretation is less clear than for the other groups. Apart from its relatively capable performance, the group's most striking features are low personal and social self-concept, and only moderate secondary attitude to secondary school. The city group is particularly small (6 per cent) but it is predominantly male (89 per cent boys). The rural group is proportionately twice as big and comprises 42 per cent boys.

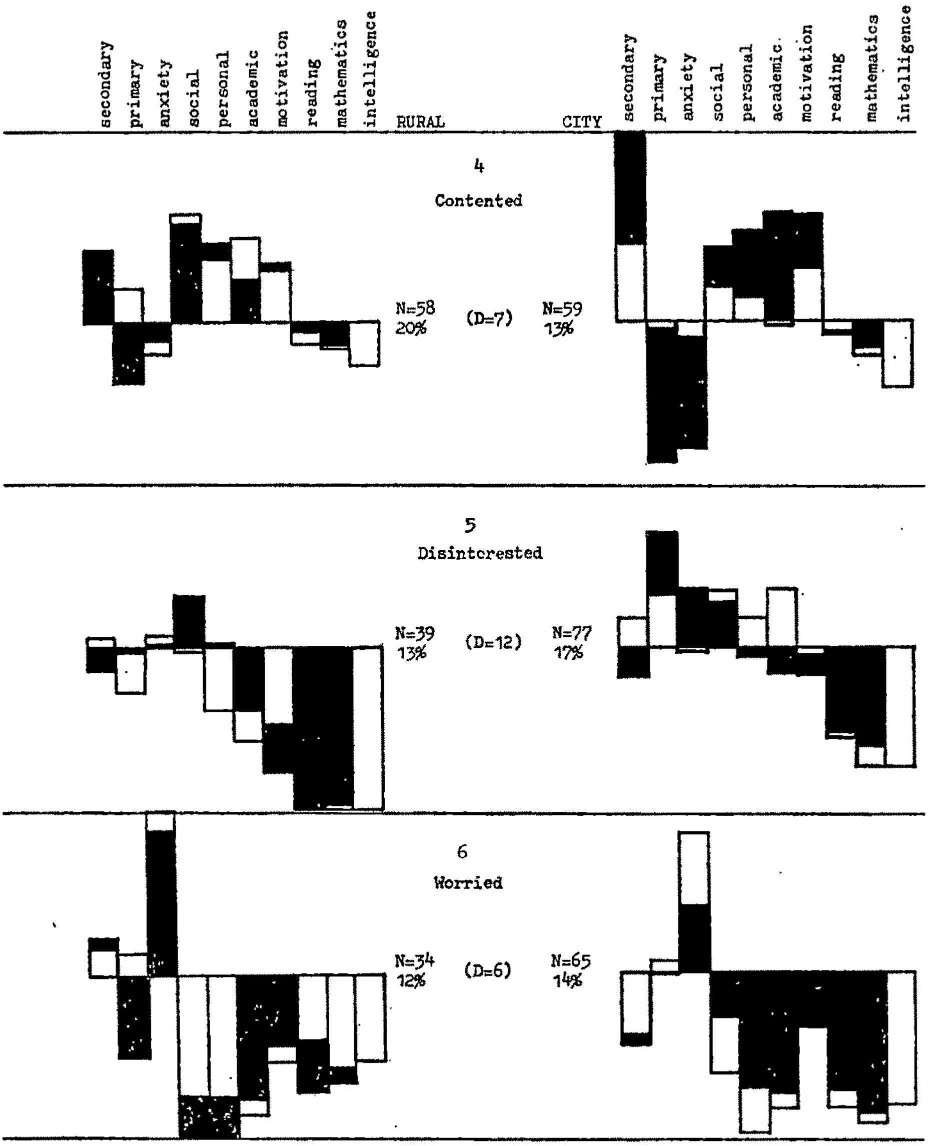
Three Low Ability Reactions

4. *Contented.* The main area of difference is in attitude to school with the city group showing similar but more extreme reactions in a favourable direction. Performance and personality patterns are almost identical. Below average intelligence is associated with somewhat better achievement and above average motivation and self-concept. Size and make-up show little variation between the samples since both groups comprise around 12 per cent of the sample and contain approximately equal proportions of boys and girls.

5. *Disinterested.* This group's name derives from its average score level across the

FIGURE 2

THE THREE LOW-ABILITY REACTIONS



Notes: see Figure 1

attitude and personality measures. The intellectual side relates low ability and achievement to average or below average motivation. There is a tendency for attitude and motivation to deteriorate on transfer, especially with the city group. Only the rural group shows any bias in sex composition since 67 per cent of its members are boys. It is also slightly smaller (13 per cent) than the corresponding city group (17 per cent).

6. *Worried.* Although the intellectual pattern of this reaction is similar to the previous one, the syndrome of high anxiety and low self-concept identifies it as a separate and disturbing group, almost the obverse of the academic reaction. In the rural group the effect seems more severe with deterioration in both self-concept and performance, even though that group's ability level is slightly higher than its city equivalent. Both groups contain about 40 per cent boys and comprise approximately 12 per cent of the sample.

DISCUSSION

In spite of the intellectual differences between the two samples as seen in Table 1, subsequent analyses show sufficient comparability to suggest that these findings on reactions to transfer are likely to generalise across many types of schools. This matches Nisbet and Entwistle's (1969) comparison of city and rural children since they also produced similar findings for the two samples.

Differential patterns of adjustment and attainment are seen in the clustering results (Figures 1 and 2). The stability of the outcome between the two samples is strong support for the contention that the six reactions implicit in this analysis represent widely occurring syndromes. The *academic* type, comprising approximately 20 per cent of each sample, depicts the traditional view of an acceptable pupil. Yet even when its obverse, the *worried* group, is included there still remains some two-thirds of the sample showing *different* reactions. The *contented* group evidences the type of child where a positive attitude to school does seem to have a beneficial effect on performance. In spite of slightly below average ability, transfer is accompanied by improved motivation and attitude, particularly in the city sample, and a continuing tendency for achievement to exceed ability. For the *capable* group, high ability is combined with low self-concept and attitude scores suggesting that for these children success is based on ability alone. That is, certain children react almost exclusively to the academic environment of secondary schooling and are relatively immune to the social and personal implications of the change. The *disinterested* reaction refers to children showing little enthusiasm for secondary schooling, but lack of success does not seem to trouble them.

For anyone trying to locate areas of concern in school transfer, the *worried* reaction, together with the remaining group, *disenchanted,* would probably qualify as major problems. The *worried* group has a similar intellectual profile to the *disinterested* group, but its personal characteristics indicate high anxiety and low self-concept. The rural group is especially important since its ability level is not unduly low, but the unsatisfactory features of this reaction do seem to worsen on transfer. Finally there is the *disenchanted* reaction, possibly the most unexpected outcome of all. This represents a group with moderately high ability but some indication of inferior performance. In that attitude and motivation both deteriorate on transfer there must be serious concern that the group's failure to adjust will continue, wasting valuable potential. At approximately one in eight of these secondary school samples, the speedy identification of this reaction cannot be overlooked. In their recent survey on school transition, Sumner and Bradley (1977) contend that: " Current attainment will continue to predicate future attainment until such time as improved teaching methods can reduce or eliminate the effects of individual differences " (page 6).

The six reactions described here not only verify that there are substantial differences in patterns of adjustment after transfer, but they also offer guidance on identification and treatment. As such they provide necessary preliminary information before individualisation of instruction can be anything like effective.

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PERSONALITY CORRELATES OF OVER-ACHIEVEMENT AND UNDER-ACHIEVEMENT

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SUMMARY. 292 Canadian Grade 7 students were given a three-part group intelligence test, a two-part mathematics test, and a three-part English test. Scores on these tests, together with teachers' grades for these subjects, were compared with personality questionnaire measures of aggression, positive and negative self-concept, and a sentence completion test of attitudes to school and other areas. Substantial correlations were obtained between the ability and personality variables, with marked sex differences. However, when multiple correlations were calculated between intelligence and personality variables as predictors of mathematics and English achievement criteria, the beta weights for personality variables were mostly small and relatively inconsistent.

INTRODUCTION

THE concept of under-achievement at school has a long history in educational-psychological research. In the 1920s psychologists generally assumed that the IQ was the major predictor of school achievement, but that other factors such as family background, personality characteristics, attitudes and interests, also contributed to academic success or failure. In 1922, Franzen advocated comparing achievement, not with chronological age, but with mental age, to yield an Accomplishment Ratio or Achievement Quotient which would show how far students were achieving less well than might be expected from their IQs or intellectual potential. The same approach was particularly emphasised in Britain by Schonell (1942), who distinguished what he called the ' backward ' from the ' retarded ' pupil. The backward were those whose educational achievements fell below their chronological age level, whereas the retarded were those whose achievements fell below their mental age level. This dichotomy has persisted in the work of a great many educational psychologists to the present day. Child guidance clinics or remedial centres often accept only the so-called retarded for remedial work, i.e. children who are scholastically backward but have average or high IQs. Yet the fallacies in this approach soon became apparent. Owing to regression it was inevitable that many more retarded cases were found among children of above average than below average intelligence. Moreover it naturally followed from the normal distributions of quotients of intellectual and educational ability that there must be as many over-achievers as under-achievers, i.e. children who were apparently achieving better than would be expected from their supposedly innate intelligence. A third criticism was that achievement discrepancies or quotients are considerably less reliable than the Mental or Educational Ages from which they are derived. Thus children found to be under-achievers when their intelligence and achievements were measured by one set of tests would not necessarily be so if a different intelligence test, or different educational tests, were applied.

Thorndike (1963) suggested a more rational statistical technique of estimating over- or under-achievement, based on the discrepancy between actual achievement scores and scores predicted on the basis of the regression of intelligence on achievement. This approach was followed by Farquhar and Payne (1964), and in two researches into characteristics of under-achievers by Banreti-Fuchs (1972, 1975), and by others.

Throughout the years there have been innumerable investigations of the correlations, either of achievement, or of achievement discrepancy scores with measures of emotional stability or neuroticism, positive or negative self-concept, anxiety, aggression, introversion, etc. (cf. Cattell *et al.*, 1966; Entwistle and Entwistle, 1970).

The correlations are usually small, and often contradictory. Sometimes, for example, the more unstable or anxious students achieve less well; but in other studies, anxiety (interpreted as drive) is associated with superior achievement. The results differ with the age group concerned, and with sex (though few writers, apart from Shaw and McCuen, 1960, have analysed the results for boys and girls separately), with socio-economic class, and with different intelligence or personality measures. Thus we are left with the conclusion that personality factors are important in determining children's achievement, but that there is little or no consensus as to which factors. Frost (1967) drew attention to the absence of clear definition of anxiety and aggression, and derived a series of scales for measuring different aspects of these traits (the Frost Self-Description Questionnaire) which has recently been revised. In almost all studies self-report personality or attitude questionnaires have been applied, and their susceptibility to social desirability and other response sets or distortions is well known (cf. Vernon, 1964). Teachers' ratings of student characteristics are even more unsatisfactory on account of halo effects.

Based on a review of the literature, and of the facilities for psychological investigations within schools, it was decided to study the personality correlates both of achievement and of discrepancies (i.e. achievement with IQ held constant), using both objective tests and teachers' school grades for English and mathematics. Grade 7 students were involved, and it was hoped that their responses to personality questions would be reasonably frank. But the questionnaire was supplemented by a Sentence Completion test, consisting of items which would display positive or negative attitudes to school, home, and other areas.

METHOD

Sample

The sample consisted of Grade 7 students from three Calgary public junior high schools. It totalled 292 students, 155 boys and 137 girls, between the ages of 12 and 13 years. The schools were chosen to be reasonably representative of the socio-economic range in the city.

Tests

A. *Intelligence.* The Canadian Cognitive Abilities Test had been administered recently to all Grade 7 students in Calgary. The test is a revision of the Lorge-Thorndike Intelligence Test, giving three separate scores, Verbal, Quantitative, and Nonverbal, or a total score. Since the correlations between these scores were quite high in both sexes (averaging 0·57), the combined IQ_T was used in most of the subsequent calculations.

B. *English Achievement.* The test used was an old version of the Moray House English Tests, consisting of 113 multiple-choice items, arranged in cyclic omnibus form. The items could be divided into three main types which were scored separately: Reading Comprehension (E_1), 29 items; Vocabulary and Word Knowledge (E_2), 27 items; Usage, including spelling, punctuation, rhymes, etc. (E_3), 57 items. E_T stands for total scores.

While intended for 10-12 year olds in the U.K., and normed over this age range, it was sufficiently difficult to give a good spread of scores in Canadian Grade 7. A time limit of 40 minutes was allowed.

C. *Mathematical Achievement.* A new multiple-choice test was devised by one of the authors (Behrens), after careful analysis of all the text books used in Grades 6 and 7 by the Calgary School System. This attempted to cover both traditional or computational mathematics (MC), and modern mathematics (MM). All 45 items in the test were intercorrelated, and subject to principal components analysis. The first five components were rotated by varimax technique, and two of them were found to differentiate rather clearly between the computational and the modern types. One should certainly not regard ' computation ' and ' modern ' as two distinct branches of mathematics. Indeed the correlations between the two types of items were mostly positive, though not as high as the correlations within the two sets. But some students do relatively better on one type of item than on the other, sufficiently so to make it worth analysing the relations of the two sub-scores to other variables, though also concentrating chiefly on the total score (MT).

D. *Teachers' Gradings*. Teachers' percentage marks in English and mathematics were made available, and a check was carried out to show that the standards of marking adopted by the different schools did not differ significantly from those to be expected from the objective test. These are referred to below as ES and MS.

E. *Personality Questionnaire*. A questionnaire was constructed from parts of the Frost Self-Description Questionnaire, and from the Coopersmith (1967) Self-Esteem Inventory. Twenty items fell under each of the following six headings: Externalised Aggression (EA), Internalised Aggression (IA), Projective Aggression (PA), together with 20 Buffer items (BI) referring to daily life activities, career choices, etc. From the Coopersmith Inventory, 20 items were indicative of Positive Self-Esteem (PE), and the same number representative of Negative Self-Esteem (NE).

Buffer items are included in the Frost Questionnaire to reduce the set among the subjects that the test is entirely concerned with unpleasant personality qualities. It had not been intended to score these, but since it turned out in the analysis that this scale had substantial correlations with other variables, it was decided to include it. It appears to measure a positive self-concept with a strong masculine flavour.

The internal consistencies of the six variables were calculated by Cronbach's Alpha coefficient, in each sex. For the five Aggression and Self-Esteem scores, reasonably high coefficients were obtained averaging 0·75 (range 0·65 to 0·83). But for the buffer items the coefficients were 0·33 in boys and 0·30 in girls, presumably because these items were not constructed to measure any homogeneous variable.

F. *Sentence Completion*. An alternative approach to personality was a Sentence Completion test constructed by Vernon (1971). Thirty-four item stems were listed, e.g.: At school I usually . . . .
My hair . . . .
The subjects' answers were scored for favourable *vs*. unfavourable attitudes, and were classified under five headings: School (S), Peers (P), Home (H), Body or Physical-Self (B), and Self-Concept (C).

The reliability of scoring these scales was studied by taking several small samples of 30 answer sheets, and having them scored independently by two markers. The figures for the first four scales were satisfactory, with coefficients ranging from 0·60 to 0·92. But even after discussion between the scorers as to the criteria for positive *vs*. negative self-concepts, and reasons for discrepancies, it was not found possible to achieve higher agreement on another sample than a reliability of 0·60.

RESULTS

Means and sex differences

Table 1 shows the means and standard deviations of boys and girls on all variables. In this table and in those that follow asterisks are used to indicate any differences which are statistically significant. Most of these differences are in the direction to be expected. It is often believed that boys do better in mathematics, but this is generally true only at high school level. In elementary school, girls tend to be at least as good. Here, the girls' score is significantly higher in modern mathematics (MM), and in school mathematics (MS), though not in computational mathematics (MC). Teachers' marks may exaggerate the differences since they tend to regard girls as better pupils all round. It is noteworthy that on IQ_2, which is based on numerical problems, there is no difference between the sexes.

TABLE 1

MEAN SCORES, STANDARD DEVIATIONS OF BOYS AND GIRLS ON ALL VARIABLES AND SIGNIFICANT SEX DIFFERENCES

Variable		Boys N=155		Girls N=137	
		Mean	σ	Mean	σ
A	Age	154·81	5·57	153·84	5·84
MC	Maths Computational	13·68	4·63	13·43	4·06
MM	Modern Maths	11·75	3·67	12·80	2·67***
MT	Maths Total	25·44	7·70	26·23	6·03
MS	School Maths	59·68	17·95	63·28	14·37**
IQ_1	Verbal	68·63	12·23	70·99	12·43*
IQ_2	Quantitative	39·81	9·57	39·79	8·50
IQ_3	Non-Verbal	62·96	10·73	64·32	8·15
IQ_T	Total IQ	171·41	27·51	175·10	24·24
E_1	Reading and Comprehension	18·81	5·67	21·61	4·89
E_2	Vocabulary	16·77	4·98	16·39	4·75
E_3	Usage	29·37	10·98	34·06	9·61***
E_T	Total English	65·36	20·44	72·07	17·44***
ES	School English	59·06	13·76	68·43	12·57***
EA	Externalised Aggression	16·25	8·03	13·74	8·36***
IA	Internalised Aggression	17·66	8·48	17·80	7·90
PA	Projective Aggression	16·39	7·48	14·09	7·62***
Agg. T.	Total Aggression	50·30	19·16	45·64	18·78**
PE	+Self Esteem	22·85	5·99	22·47	6·56
NE	−ve Self Esteem	15·33	7·23	15·19	7·94
S	School Attitude	1·95	4·22	2·06	3·49
P	Peers	3·16	3·87	3·13	3·64
H	Home Factors	−0·66	2·61	−0·85	2·85
B	Physical Self	3·06	3·44	2·96	3·39
C	Self Concept	−2·47	3·06	−2·58	3·30
BI	Buffer Items	13·80	4·31	12·35	4·06***

* $P<\cdot05$; ** $P<\cdot01$; *** $P<\cdot001$

Girls show a higher verbal intelligence score as confirmed by IQ_1. Generally, girls are regarded as being better at English and this is adequately confirmed by E_1 (Reading and Comprehension), E_3 (Miscellaneous and Usage) and E_T (Total Score in English), E_S (Teacher Score in English), but not by E_2 (Vocabulary). Several previous researchers have shown that boys tend to be superior in vocabulary definitions. Clearly, girls are much superior to boys in most aspects of English, and this fits in with the common observation that many more boys than girls have reading difficulties.

Among the personality variables there are no differences on the Sentence Completion measures, though girls might have been expected to score more favourably in school attitudes (S). Nor are there any differences on the Coopersmith positive or negative Self-Esteem (PE and NE). In the Self-Description Questionnaire, boys are significantly higher in externalised aggression (EA), in projective aggression (PA), and in total aggression (AGG_T). This seems to confirm many other researches that show boys are overall more aggressive than girls. But there is no appreciable difference for internalised aggression (IA). There is a highly significant difference on buffer items (BI) presumably because more of these refer to sports and masculine types of occupations. Overall, boys tend to show larger variances on all ability and achievement variables, which again is commonly observed in other researches. This implies that, while the majority of the most backward students are boys, so are many of the most able students.

Personality correlates of achievement

Correlations between all the intellectual, achievement and personality variables in each sex were calculated, but are too lengthy to reproduce here. (Further details are available from the authors.) The IQ measures were related to achievement tests or school grades much as might be expected, with coefficients ranging from 0·56 to 0·76. The correlations between objective tests and grades for mathematics (MT with MS) were 0·77 (boys) and 0·64 (girls), whereas for English the corresponding figures were 0·50 and 0·52. This indicates that the skills in English tested by the objective test were less related to work done in school than was the case with mathematics.

Twenty-five per cent of all the correlations among boys between ability and personality variables were statistically significant; the corresponding figure for girls was 43·5 per cent. Thus there is considerable overlapping between achievement scores and personality. Table 2 shows the most interesting indicators of the effects of personality on mathematics and English achievement, in both sexes.

TABLE 2

CORRELATIONS BETWEEN AGGRESSIVE OR ATTITUDE SCORES WITH ACHIEVEMENTS

Achievement (Boys)	EA	IA	PA	NE	S	C
MT	−·05	−·12	·03	−·22**	·21**	·19*
MS	−·10	−·14	−·06	−·27**	·16*	·09
ET	−·17*	−·13	−·00	−·20*	·16*	·08
ES	−·22**	−·11	−·07	−·23**	·24**	·13
Total IQ	−·13	−·18*	−·06	−·25**	−·00	·13
Achievement (Girls)	**EA**	**IA**	**PA**	**NE**	**S**	**C**
MT	−·14	−·30**	−·30**	−·30	·18*	·13
MS	−·10	−·31**	−·31**	−·29	·12	−·02
ET	−·16	−·29**	−·36**	−·28**	·24**	·17*
ES	−·26**	−·24**	−·41**	−·25**	·38**	·26**
Total IQ	−·12	−·24**	−·40**	−·27**	·30**	·23**

* significant at ·05; ** significant at ·01

The total IQ correlates negatively with all three measures of aggression, and with negative self-esteem (NE), the coefficients being mostly higher in girls than in boys. In particular, IQ with projective aggression reaches as high as −0·40 in girls, though in boys there is no relation. There are also small positive correlations with favourable attitudes to school (S), and to self (C) in girls.

On all the achievement measures, boys tend to show low negative correlations with aggression, the highest being −0·22 for externalised aggression. In girls, however, both internalised and projective aggression give negative correlations throughout. In both sexes there are significant negative correlations with negative self-esteem (NE), and positive correlations with school attitude (S). Thus there is a general tendency for poor achievers to admit aggressive tendencies (especially among girls), negative self-concepts and dislike of school. But the pattern of relations to aggression differs between the sexes, since externalised aggression is most predictive in boys, internalised and projective aggression in girls. This latter finding accords with Frost's (1967) results. Positive self-esteem scores (PE) give insignificant correlations throughout, hence they are not listed here. But clearly PE and NE represent different traits; one is not just the opposite of the other; their intercorrelations were −0·44 in boys and −0·56 in girls.

Apart from school attitude, few of the Sentence Completion measures yield any clear pattern. However, in boys the favourable body concept (B) correlates −0·21 with IQ, −0·26 and −0·19 with English test and grades, suggesting that duller and more backward boys are apt to take more pride in their own physical qualities. The Buffer Items (BI) likewise correlate significantly (0·23 upwards) with PE, S, P and B in boys. In girls only the favourable Self-concept (C) gave significant correlations with English and IQ. Thus there are sex differences in the relations of self-report measures and Sentence Completion attitudes to achievement, as well as differences between the means. Factor analyses of all the variables were carried out in each sex, showing again considerably different patterns. Details may be obtained from the authors.

Correlations with achievement discrepancies

As explained earlier, the characteristics of over- and under-achievers (as usually defined) would be expected to differ from the characteristics of good and poor students whose achievement is largely associated with high or low IQ. The question which concerns us here is how much better can we predict achievement by taking account of personality variables as well as IQ. Multiple correlations were calculated for the four main criteria of achievement with IQ and 10 personality variables as predictors, with the results shown in Table 3.

TABLE 3

SQUARED MULTIPLE CORRELATIONS SHOWING THE AMOUNT OF VARIANCE IN THE CRITERIA PREDICTED BY IQ AND PERSONALITY

Criterion	(i) Variance predicted by IQ alone	(ii) Variance predicted by Personality variables	(iii) Predicted by IQ + Personality	(iv) Difference between (i) and (iii)
MT	·50	·19	·57	·07
MS	·40	·18	·48	·08
ET	·49	·18	·54	·05
ES	·32	·24	·42	·10

NOTE: sexes combined in this analysis

TABLE 4

SIGNIFICANT BETA WEIGHTS FOR PREDICTION OF ACHIEVEMENT BY PERSONALITY VARIABLES, HOLDING IQ CONSTANT

Criteria	Boys		Girls	
MT	S	·25**	IA	−·22*
	EA	·12*	PA	−·21*
			P	−·19*
MS	S	·16**	IA	−·24**
			C	−·21**
ET	S	·20**	IA	−·12
	B	−·18**		
ES	S	·27**	S	·19*
	B	−·15*	PA	−·17*

Clearly the personality variables do measure something relevant to achievement, over and above IQ, but the additions they make to the multiple correlations, as shown in column (iv), are quite small.

However, some of the particular personality variables did achieve significant beta weights in the multiple regression equations when IQ was held constant. As the tables are very lengthy, Table 4 lists only those variables showing significant beta weights.

Thus there are only 15 significant predictions out of a possible total of 80. Favourable school attitudes figure in all the boys' equations, and positive body concept (B) in both English criteria. Among girls, however, internalised and/or projective aggression appear most frequently, and there are negative weights for attitude to peers in MT, and to self in MS. It is difficult to see any interpretation for the latter results.

Contrasts between over- and under-achievement groups

The more traditional technique was also applied to the data. Over- or under-achievers were identified, not by taking the differences between, or the ratios of, achievement and intelligence, but by calculating the expected achievement from the regression line of intelligence on achievement, and separating off those whose actual achievement reached 0·8 sigma (or more) above or below expectation. This analysis yields approximately 20 per cent of over-achievers, 20 per cent of under-achievers, the remaining 60 per cent being medium achievers.

The mean scores of these three groups were compared, in each sex, and ' t ' was used to test significance of any differences (see Table 5). Here the number of significant results was even smaller, amounting to 19 out of 264 possible; and they did not coincide closely with the results of the previous multiple correlation analysis.

TABLE 5

VALUES OF 't' FOR DIFFERENCES IN PERSONALITY BETWEEN OVER-, MEDIUM AND UNDER-ACHIEVERS

Criteria	Boys			Girls		
MT	BI	(MU)	+2·80**	NE	(OU)	-2·35*
	BI	(OU)	+2·02*	NE	(OM)	-2·02*
	S	(OU)	+2·31*	P	(OM)	-2·94**
MS	S	(OU)	+2·17	P	(OM)	-2·80**
				B	(OU)	-2·70**
				C	(OM)	-2·07*
ET	BI	(OM)	-2·19*	Nil		
	S	(OU)	2·32*			
	S	(MU)	2·18*			
ES	EA	(MU)	-2·34*	PA	(MU)	-2·14*
	S	(OU)	2·88**	S	(OU)	2·38*
	S	(MU)	2·05*	S	(MU)	2·26*

NOTE: The letters O, M and U refer to the over-, medium and under-achievers. Thus MU signifies a difference between the medium and under-achievers.

Nevertheless school attitude is the best predictor of boys, as it was in Table 4. Buffer items (BI), which had not been included in the multiple regression analysis, now seems to affect MT positively, but ET negatively. Among girls, negative self-esteem, and unfavourable attitudes to peers and self, affect mathematics achievement, while school attitude becomes important in relation to ES. There are some resemblances between Tables 4 and 5, but probably the effects of personality differences (when IQ is excluded) are small and rather unreliable. And the different techniques of multiple regression and of group differences may affect the results.

One of the original aims of the research was to try to find whether different aspects of English (vocabulary, usage, etc.) or mathematics (computational or modern) were affected by different personality variables. This analysis was carried out, but any differences were too small and unreliable to be quoted here.

CONCLUSION

Quite substantial correlations were obtained between personality variables and achievement in mathematics and English (whether measured by objective tests, or school marks). In particular the 3 types of aggression, the negative self-esteem measure, and favourable attitude to school had rather consistent effects, which differed noticeably between the sexes. Further studies of the problem should certainly treat the sexes separately.

The concepts of over- and under-achievement were criticised in the introduction, and this study employed two different techniques of holding IQ constant in order to study the personality correlates of achievement discrepancy, or of over- and under-achievement. Although significant differences were found on a number of variables, these were small and probably rather unreliable, so that no clear pattern emerged, apart from the obvious generalisation that favourable attitude to school influences achievement in both English and mathematics, especially among boys. Internalised or projective aggression tendencies among girls appeared important in an analysis based on multiple regression, but this was not confirmed in an analysis based on over-, medium- and under-achieving groups.

A reasonable criticism of the present findings would be that the personality instruments employed were less relevant to over- or under-achievement than others that might be devised, or which are already on the market. Thus Cattell and his collaborators (1966) claim that his High School Personality Questionnaire and School Motivation Analysis test each contributed as much to the prediction of school achievement as did his Culture-Fair Intelligence Test. But, even where substantial prediction *is* reported, the direction of causation is still uncertain. Does failure at school engender compensatory hostility or negative social attitudes? Or do some students with longstanding personality characteristics adjust well, others badly, to school learning?

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AN APPROACH TO THE DEFINITION OF COGNITIVE DEVELOPMENTAL STAGES IN SCHOOL MATHEMATICS

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SUMMARY. Three levels of mathematical concepts are outlined. Level 1 consists of concepts which depend on binary relations and unary operations. Level 2 consists of concepts which can be encoded as binary operations, and Level 3 consists of concepts which can be expressed as compositions of binary operations. Three levels of cognitive development which correspond in theory to the levels of mathematical concept understanding are outlined, and appropriate illustrative performances are given. Samples of Australian and Canadian school children were tested on problems designed to require Level 2 or 3 mathematical understanding. Success rates were consistent with predictions for each age group. The application of cognitive development theory to the teaching of mathematics to children is considered, and an alternative approach is proposed. It is specifically predicted that ability to attain concepts at any of the three levels will be a function of information-processing capacity, which will be a necessary but not sufficient condition. Once the minimum required information-processing capacity is available, acquisition will be a function of experience and task variables. Thus concepts should be expected to emerge neither synchronously nor in any defined sequence, and they should emerge gradually rather than abruptly across an entire population.

INTRODUCTION

ALTHOUGH the field of cognitive development has been primarily concerned with the child's capacity for logical thinking, there have been comparatively few attempts to apply the now substantial data base in the area to mathematics education. This failure might seem to be surprising in view of the links between mathematics and logic, but might be at least partly attributable to the fact that Piaget's theory was not really designed to be applied to school mathematics. Piaget's theory of groupings, the 16 binary operations, and the INRC group do not relate to the kinds of mathematical concepts that are of interest to most western educators, at least without further interpretation. The consequent disillusionment with the potential of Piagetian theory in mathematics education has been expressed on a variety of other grounds by Smedslund (1977), Brown and Desforges (1977), and Anthony (1977). Such reactions could be premature, however, in that the full potential of cognitive developmental stage theory in this area may not yet have been realised. It seems desirable now to extend Piagetian theory in an attempt to make it work better in the area of mathematics education.

One of the few systematic attempts to apply cognitive development theory to mathematics education is that by Malpas and Brown (1974), who were able reliably to separate O-level mathematics items into concrete and formal operational categories, but their criteria are general and have to be applied in a judgmental manner. Malpas and Brown do not give a systematic item-by-item account of just what it is in an item which puts it within the scope of formal operational children but beyond concrete operational children.

One of the most extensive attempts to apply cognitive developmental theory to mathematics education is that of Collis (1975, 1978) who proposes that cognitive stage can be determined on either a structural dimension or an element dimension. Collis also postulates that concrete operations differ from formal operational processes on such factors as acceptance of lack of closure and ability to deal with multiple interacting systems. The present approach has much in common with that of Collis, but attempts to subsume the various characteristics of concrete and formal reasoning under the single factor of operational complexity. It also goes somewhat beyond

Collis' work in proposing a model of psychological processes which would predict the observed characteristics of mathematical reasoning at each stage. In particular, it will be proposed that information processing considerations limit the highest level of cognitive system which children can learn. This is because more information is required to detect an inconsistency in the way a higher level system is matched to problem elements than is needed with a lower level system. This problem will be taken up again in the discussion.

The essence of the present approach is that there are three levels of mathematical concept development which correspond to three stages of cognitive development. The three mathematical stages are: the stage of unary operations, the stage of single binary operations, and the stage of compositions of binary operations. The proposed stages can be identified to some extent with Piagetian preoperational, concrete operational, and formal operational stages respectively.

There is evidence that children know a certain amount about mathematics before they gain any knowledge of mathematical operations. Such knowledge would include ability to count, to estimate small numbers, to distinguish more, less and same, and to recognise that cardinal number is increased by adding more, decreased by removing some. Actually, the acquisition of these abilities was investigated in a recent paper by Schaeffer *et al.* (1974), but the authors seem to regard them as the whole of a child's understanding of number. By contrast, the present formulations would suggest that these abilities are confined to the preoperational level of number understanding.

Then there are number ideas which cannot be understood without operations. An obvious example is the concept of negative numbers, which are arrived at by subtracting a larger number from a smaller one. The concepts of sum, product, difference and quotient are further examples of concepts which have no meaning in the absence of mathematical operations. A further example is finding an unknown; e.g. if $a+4=7$, finding a depends on the operation of arithmetical addition. All these concepts depend on single binary operations, in particular on the operations of addition, multiplication and the complementary operations of subtraction and division.

Then we have concepts which depend on compositions of binary operations. The prototypical example is the concept of the proportion, which involves a comparison of two ratios, each ratio itself comprising the operation of division. A further example would be an expression such as $a-(x-y)=a-x+y$. Here we have an operation on an operation, and a unique result is defined. These concepts depend on compositions of binary operations.

How are these levels of mathematical concepts related to cognitive developmental stages? It is proposed to trace the relationship at a theoretical level first, then at the empirical level. We will consider each stage in turn.

Between age two and age five average children have been variously conceptualised as preoperational (Piaget, 1950), iconic (Bruner, 1964), as non-synthesisers (Farnham-Diggory, 1972), as non-mediators (Kendler and Kendler, 1962), as lacking " the analytic system of elective significative connections which are produced by speech " (Luria, 1961), or as being in an associative stage (as against a cognitive one—White, 1965). It has been proposed by Halford (1978b) that this age range is a period when the child relates internal, cognitive symbols to external objects and events, and to other symbols, in one-to-one fashion, corresponding to one-to-one mappings. This enables the child to cognise binary relations, simple functions, and unary operations.

To see how this works we will briefly consider the kinds of symbolic processes which are postulated at this age range. There are three kinds of relations: symbol-symbol (S-S) relations, symbol-object (S-O) relations, and object-object (O-O) relations. An example of an S-S relation is any association between purely mental events (mental elements), such as the thought that a man is bigger than a boy, or the reflection that words are symbols. The simplest example of S-O relations is naming, such as the association of the word-cat to the object-cat. The O-O category of relationships refers to relations between objects and events in the external world, such as the size of a man and the size of a boy; obviously, S-S relations may, but need not, parallel O-O relations.

Structures of these relations can be formed. An interesting theoretical case is where we have an S-S relation, two S-O relations and an O-O relation in correspondence, as shown in Figure 1a. In this situation, the relations exercise a kind of mutual constraint. For instance, if the symbol man is related to the object man, and the symbol boy is related to the object boy, then the S-S and O-O relations will tend to be matched. Actually several relations of the same kind may be strung together forming simple structures, such as the example taken from a speech sample of a 3-year-old as shown in Figure 1b.

FIGURE 1A

A SIMPLE STRUCTURE FORMED FROM LEVEL 1 S–S AND S–O RELATIONS

$$\begin{tikzcd}
S \arrow[r] \arrow[d] & S \arrow[d] \\
O \arrow[r] & O
\end{tikzcd}$$

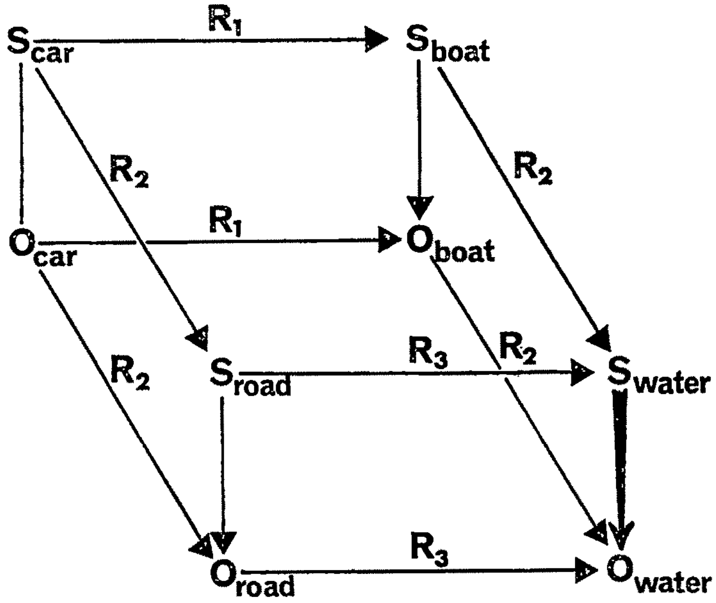
The child had said: " Cars go on road, boats go on water ". This spontaneous utterance presumably reflected the fact that the child had just closed (completed) the set of S-S relations shown. A structure of this sort would be sufficient to enable analogies problems, such as "... cars are to roads as boats are to ... ? " to be solved. Interestingly, analogies are given at age three in the Binet–Simon tests.

Other performances which would be made possible by this level of structure would be the use of grammatical rules at the level of unary operations, such as negation, change from present to past tense, and change from indicative to interrogative. As the almost-classical work of Berko (1958) has shown, children can do these things within this age range.

Between the ages of 6 and 11 years children have been characterised as concrete operational (Piaget), as symbolic (Bruner), as synthesisers (Farnham–Diggory), as using mediation (Kendler and Kendler, 1962), and as cognitive (White). It has been

FIGURE 1B

A MORE COMPLEX STRUCTURE, REFLECTED IN A SPEECH SAMPLE OF A 3-4-YEAR-OLD, AND CONSISTING OF LEVEL 1 S–S AND S–O RELATIONS



proposed by Halford (1978b) that in this period children form associations between symbol elements in the form: S,S→S.

This change opens up a large range of new performances, most of which are recognisable as binary operations of some kind. This brings within the child's grasp such concepts as transitivity, classification operations, and addition of units, which in turn lead to satisfactory performance on tasks such as seriation, disjunctive and conjunctive classifications, and quantification concepts such as conservation.

Nowhere has cognitive development literature given rise to more confusion than in the area broadly defined by Piaget's concrete operational concepts. Among the misconceptions was the notion that conservation would be a prerequisite for mathematical understanding, which was not demonstrated by Piaget's work and did not necessarily follow from his theory. It is true that he says (Piaget, 1952) that conservation is basic to all rational activity. Since this statement appears on page 1 of the book it has received widespread attention. However, anything more than a superficial reading of the rest of the book is enough to indicate that it does not follow that performance on any given conservation test will be a necessary precondition for acquisition of any mathematical concept. Furthermore, the hypothesis has now been disconfirmed empirically by Mpiangu and Gentile (1975).

A more appropriate inference from the data on cognitive development of children aged 6 to 11 years would be that they can learn systems which are based on binary operations. Thus they understand that quantities depend on the addition of units, understand transitivity, recognise that the whole is more than any of its parts (disjunctive classification), or that elements can be categorised by reference to two attributes (conjunctive classification), and interpret stimuli as attributes on a dimension. As Sheppard (1974) has shown, they can also learn groups, which are a special case of binary operations, which may well account for integration of spatial relationships.

The implication for mathematics education should be that in the 6 to 11 age range children are ready to learn mathematical concepts which are based on single binary operations. Before this age they would be capable of learning mathematical concepts which involved only unary operations or no operations at all. Six- to 11-year-old children would not yet be capable of learning mathematical or other concepts which depended on compositions of binary operations. Existing data on children aged 11 years and over are even more difficult to interpret than for earlier age groups. Piaget contends that formal operational children use the 16 binary operations of propositional logic, but the evidence that adolescents or adults have all these operations is quite inadequate. Several researchers have shown that children younger than 11 have at least partial understanding of some of these operations (Peel, 1967; Suppes and Feldman, 1971). Piaget's contention that older adolescents have the INRC group has been criticised by Lunzer (1965).

It is widely agreed that formal operational children can reason by hypothesis, and that they tend to reverse the relation between thought and reality which exists in the concrete operational children, so that they see reality as a reflection of theoretical possibilities. However, there is evidence from concept attainment studies and elsewhere that children in the 6- to 11-year age range do test hypotheses (e.g., Gholson and McConville, 1974; Gholson and Danziger, 1975).

A possible resolution of the conflicting lines of evidence may come about from a redefinition of what formal operational children can do. It would be in keeping with the concepts underlying this paper if formal operational children can test hypotheses which incorporate a binary operational concept, such as disjunction, conjunction or implication. Thus to test the hypothesis that a set of objects are all green and triangular, it is necessary to transform the hypothesis into its inverse, not green and not triangular. This requires the child to relate one binary operational concept to another, which concrete operational children should not be able to do. On the other hand concrete operational children could relate a binary operational concept to a concrete situation, and would therefore be able to recognise that the hypothesis is invalidated if they find contrary evidence, such as a red circle. They would not be able to specify in advance the kind of evidence which would infirm the hypothesis, if the hypothesis was based on a binary operation. If the hypothesis is unidimensional, concrete operational children should be able to specify the kind of evidence which would invalidate it, since they should be quite capable of taking the inverse of a hypothesis such as " all red ", i.e. ". . . not red ".

The implications of this view of cognitive development would be in the form of predictions concerning age-related limits to the complexity of mathematical concepts which children should be able to learn. Thus before approximately 5 years of age, only unary operations, simple functions and binary relations should be possible for most children. After age 5 until approximately 11 years of age, concepts based on binary operations should constitute the upper limit of conceptual development, and concepts which depend on a composition of binary operations become possible after 11 years.

Mathematical problems must be encoded or translated into an appropriate set of concepts before they can be solved. Thus mathematical problems should be analysable according to the complexity of concepts which are required for their solution. For instance a mathematical problem such as $a+6=10$ can be encoded as a single binary operation, no matter what form is used for its presentation. However, a problem such as $3/6+5/12=a$ cannot be expressed as a single binary operation and is more complex than the problem above, as well as being more complex than a problem such as $a = 5 + 9 + 3 + 2$, which only requires a binary operational concept to be applied several times in succession.

In the two experiments which follow, children in two age groups, 6 to 10 years, and 11 to 16 years, were given a variety of mathematical items which required them to match either one operation, or a composition of two or more operations, to the elements of the problem situation. It would be predicted that items which require only one operation should be possible in the 6 to 10 age group, but those which require compositions of operations should only be possible for the 11 to 16 age group. This should be true independently of such factors as computational skills and ability to apply the relevant formulae. Two similar experiments were conducted, one in Australia and one in Canada, thereby minimising the possibility that the results might have been due to idiosyncrasies of the teaching method in either country.

EXPERIMENT I

METHOD

Sample

This consisted of 94 boys from a state primary school and a state high school in a lower middle-class area of Newcastle, N.S.W. There were 32 fifth class primary school boys (mean age = 10 years, 4 months), 36 Form 1C high school boys (mean age = 12 years, 5 months) and 26 Form 5 high school boys (mean age = 16 years, 1 month).

Procedure

The pupils were given four specially constructed tests, the items of which are summarised below. The teachers were consulted about the most appropriate format and instructions, and wherever any doubt existed as to whether perfect communication would be achieved, practice items were used. The tests were administered to the children in their normal mathematics lessons, with the usual teacher present. The instructions and the practice items were contained on the test form, and the children were instructed to write their answers and their rough work on the forms. The experimenter read carefully through the instructions with the subjects following on their own forms, and also worked through the first of each set of practice examples with them. The experimenter then asked whether there were any questions. When these had been dealt with the subjects were instructed to begin. The test was untimed.

Test 1 was basically a test of equation solving. Items 25 to 32 were based on Collis (1971, 1975). Items 1-4 merely require a single operation to be performed. Items 5 to 8 require some rearranging to match the operation to the example, and Items 9 to 12 and 13 to 16 require some rearranging, and then two occurrences of the same operation must be matched to the item. Items 17 to 20 require two operations to be performed in sequence, but there is no difficulty matching the operations to be performed with the problem as presented. These items are intended as controls for Items 25, 27, 30 and 31, which require the same kind of computation, but where difficulty in matching the operations-to-be-performed to the problem does exist. Items 17-20 control for ability to perform the arithmetic necessary for Items 25, 27, 30, 31. Items 21 to 24 control for the rearranging procedure in Items 25, 27, 30, 31. Items 21 to 24 require two operations to be performed with rearranging, but it is easy to see what operations the items require. Items 26, 28, 29 and 32 are similar to Items 25, 27, 30 and 31 but the need to rearrange in such a way that an appropriate composition of operations is matched to the item is avoided by the commutativity of the operations employed.

Thus only Items 25, 27, 30 and 31 would be considered formal operational in the sense discussed in the introduction, i.e. that they require a composition of binary operations to be matched to each problem. The other items require only a single

Types of Items Used in Test 1

General Instructions

All the letters stand for numbers between 1 and 20.
Solve the following equations.

Item Numbers	Description	Sample Items	Classification
1–4	Single operation.	$a=8-5$ $d=8\div4$	Concrete
5–8	Single operation, with rearranging.	$7=x-3$ $3\times S=6$	Concrete
9–12	One operation repeated, with rearranging.	$3+a+a=7$	Concrete
13–16	As for 9–12, with letters.	$3\times d\times d=27$	Concrete
17–20	Two operations, no rearranging.	$a=(9-4)+7$ $1=\frac{6\times8}{4}$	Concrete
21–24	Two operations, with rearranging.	$2+y=3+3$ $2\times3\times m=24$	Concrete
26, 28, 29, 32	Two operations, with symmetry.	$4\times x=3\times4$ $3+8=g+3$	Concrete
25, 27, 30, 31	Two operations, which need to be coordinated.	$8-3=n-8$ $10\div5=f\div10$	Formal

binary operation to be matched to the problem, or they require several binary operations to be performed in sequence. However only one operation must be matched to the problem elements at a time, not two at once as with the formal operational items.

Types of Items Used in Test 2, Experiment I

Item Numbers	Description	Sample Items	Classification
1–4	One operation.	$a=6+4$ $x=24\div4$	Concrete
5–10	Two operations, with parentheses; no rearranging.	$q=(6+1)-2$ $r=(13-7)-4$	Concrete or* formal
11–14	One operation, used twice, with parentheses; response " correct " or " incorrect " required.	$10-(5-3)=2$ $(9-4)-4=8$	Concrete or* formal
15–19	Two operations, with parentheses; judgment of equality of expressions required.	$(7+3)-2=7+(3-2)$ $(8\times4)\div2=8\times(4\div2)$	Concrete or* formal
20–29	Two operations; response of adding parentheses required.	$10-2+1=9$	Concrete or* formal

* See text for explanation.

Test 2 is designed to test ability to perform two operations in sequence, with the sequence of operations indicated by parentheses. Since Piaget (1957) argues that concrete operational logic lacks associativity, this would suggest children at this age would not grasp mathematical concepts which depend on the order in which operations are performed, and therefore would have difficulty interpreting parentheses. On the other hand the present approach would suggest that since the operations only have to be performed in sequence, concrete operational children should be capable of performing correctly.

Types of Items Used in Test 3, Experiment I

Item Numbers	Description	Sample Items	Classification
1–4	One unknown operation.	$3 \circ 6 = 9$ $1 \circ 0 = 0$	Concrete
5–8	Two operations, one unknown.	$(3 \times 5) \circ 5 = 10$ $(3 * 6) \div 3 = 6$	Concrete
9–12	One unknown operation, used twice.	$(2 * 2) * 2 = 6$ $(2 \circ 2) \circ 1 = 4$	Concrete
13–16	Two unknown operations.	$(4 * 2) \circ 3 = 2$ $(6 * 5) \circ 3 = 3$	Formal
17–19	One unknown operation, used twice, with unknown variable in two items; response of recognising all possible values of unknowns required.	$(4 \circ 2) \circ 1 = 4 \circ (2 \circ 1)$ $(a \circ 2) \circ 2a = 8$ $(a \circ 2) \circ a = 8$	Formal

Test 3 requires an unknown operation to be found. Items 1 to 12 require one operation to be matched to the elements of the problem or require two operations to be matched one at a time. On the other hand, Items 13 to 19 require two operations to be matched to the problem simultaneously. Therefore the first group of items is considered concrete and the latter group formal.

Types of Items Used in Test 4, Experiment I

Item Numbers	Description	Sample Items	Classification
1–16	One operation in each expression, small numbers.	$\frac{4}{2}, \frac{8}{4}$ $6 \times 5, 3 \times 10$	Concrete
17–20	Two operations in each expression, or large numbers.	$\frac{6 \times 4}{2}, \frac{6 \times 8}{4}$ $198 \times 40, 99 \times 80$ $96 \times 48, 96 \times 24$	Formal
21–23	One operation in each expression, with unknown variables.	$\frac{a}{c}, \frac{a}{x}$ $\frac{x}{y}, \frac{x}{2y}$	Formal
24–28	Two operations in each expression, with unknown variables.	$\frac{a \times b}{c}, \frac{a \times 2b}{2c}$ $\frac{a \times b}{c}, \frac{3a \times 3b}{6c}$	Formal

Test 4 requires the children to compare the results of two operations and decide whether they would be the same or different or whether it is impossible to tell. Items 1 to 16 have small numbers so that it would be fairly easy to perform each operation in turn and compare the answers. These items are thus considered to be concrete. In Items 17 to 20 two operations have to be compared. Using arithmetic to reduce each expression to a single integer is discouraged by having each expression multiplied by a constant (6 × . . .) as in the first item, or by using large numbers as in the second item. Thus in the first item the best strategy is to say that the right hand expression differs from the left in that the numerator and denominator have both been multiplied by two, therefore the expressions are the same. This kind of strategy is obligatory in Items 21 to 23 because the numbers are unknowns. In Items 24 to 28, the same situation prevails but there are two items in each expression. Test 4 was not given to children in the primary school because the teacher considered it too hard.

RESULTS AND DISCUSSION

The proportion of correct responses for each group on each set of items is shown in Table 1. On Test 1 all groups performed at a high level on all the concrete items. Items 25, 27, 30 and 31, which were considered to be formal, produced a low level of performance in the 10- to 11-year-olds. Error analysis showed that 65 per cent of errors in the 10- to 11-year group and 80 per cent in the 12- to 13-year group were based on an inappropriate commutativity principle. For instance, on the item $8-3=n-8$, the answer would be $n=3$. As Collis (1975) points out, commutativity is essentially a concrete operational level concept. Thus these errors reflect misapplication of a rule to the item. On the other hand it would not be justifiable to conclude that the error was caused by the selection of the wrong rule, since it is equally likely that the wrong rule was selected because the correct rule was too complex for the children to match to the problem. The correct rule depends on transforming the item into the expression $n=8-3+8$, which requires the child to match a composition of two operations to the problem-as-presented.

Performance on Items 17 to 20 shows that the same children can perform the necessary arithmetic once the problem is presented in a form which enables them to perform each operation in turn. Performance on Items 21 to 24 shows that the necessary rearranging is also within their scope. What they cannot do is find a composition of two operations which is consistent with the initial expression.

On Test 2 there is a fairly uniformly high level of performance on all items, showing that performance of two operations in sequence and interpretation of parentheses present no special problems to children in any of the age groups.

On Test 3 there is a uniformly high level of performance on Items 1 to 12, which were predicted to be concrete. On Items 13 to 16, which were predicted to be formal, 10- to 11-year-olds have just passed the 50 per cent point. This would be consistent with the use of age 10:6 as the dividing line between concrete and formal, as this would make this age group marginal formal operational. Items 17-19 are not mastered until 16 to 17 years of age. Whereas Items 13 to 16 require nothing more than the simultaneous matching of two operations to the problem-as-presented, and therefore might be considered to be minimally difficult formal operational, Items 17 to 19 require fairly good trial-and-error strategies for successful matching. They therefore present difficulties which go beyond the minimum necessary for the formal operational level.

In Test 4 there is a high level of performance on Items 1 to 19, but the 12- to 13-year-olds have difficulty dealing with the items which require them to deal with unknown numbers. Although theoretically the same process is required as with the

TABLE 1

PROPORTION OF CORRECT RESPONSES ON EACH SET OF ITEMS AT EACH AGE LEVEL IN EXPERIMENT I

	Test 1								Test 2				
Items:	1–4	5–8	9–12	13–16	17–20	21–24	26, 28, 29, 32	25, 27, 30, 31	1–4	5–10	11–14	15, 17, 18, 19	20–29
Schools Class 5B 10–11 years	·99	·81	·76	·81	·86	·93	·92	·24	·96	·90	·82	·76	·83
Form 1C 12–13 years	1·00	·97	·96	·97	·96	·96	·97	·69	·97	·97	·94	·90	·94
Form 5 16–17 years	1·00	·94	·82	·89	·97	·94	1·00	·91	·99	·99	·93	·88	·96

	Test 3					Test 4						
Items:	1–4	5–8	9–12	13–16	17–19	1–9	10, 12	11, 13	14–16	17–20	21–23	24–28
Class 5B 10–11 years	·84	·94	·80	·51	·16	—	—	—	—	—	—	—
Form 1C 12–13 years	·96	·97	·91	·89	·45	·96	·96	1·00	·95	·87	·43	·42
Form 5 16–17 years	·97	·95	·97	·91	·79	·99	·98	1·00	·98	·91	·95	·66

earlier items, it is possible that most children find it harder to select the appropriate strategy when presented with unknowns.

EXPERIMENT II

The experiment was replicated in Canada for three reasons. The first was to validate the results in a country which had a decidedly different teaching style and pedagogical philosophy. Perhaps the main differences between Australian and Canadian schools can be best expressed by reference to the traditional-modern dimension. Thus at the time at which the studies were carried out, Canadian schools featured more open, ungraded classrooms, less rigid discipline, more concrete teaching aids, smaller classes and more emphasis on behavioural objectives. Secondly, it was felt desirable to sample a wider age range, particularly at the lower end, and thirdly to provide equal numbers of items in each set so as to facilitate statistical treatment. Because of time pressure and because its results seemed to be less interesting than for the other tests, Test 2 was eliminated.

METHOD

Sample

This consisted of 133 children from a small rural school in Eastern Ontario. With a few exceptions, their academic performance was somewhat below average. The entire class was tested at each level from Grade 4 to Grade 8. The number in each grade was: Grade 4, 31; Grade 5, 28; Grade 6, 23; Grade 7, 25; Grade 8, 26.

Procedure

The format of the tests was modified to suit Canadian conditions, following consultation with teachers. In other respects the procedure was as for Experiment I. The number of items was also adjusted in certain cases, but the items were all designed on essentially the same considerations as in Experiment I. The three tests are summarised below.

TYPES OF ITEMS USED IN TEST 1, EXPERIMENT II

Item Numbers	Description	Sample Items	Classification
1–4	One operation.	$\square = 8 - 5$ $\square = 8 \div 4$	Concrete
5–8	One operation, with rearranging.	$7 = \square - 3$ $3 \times \square = 6$	Concrete
9–12	One operation, used twice, two unknown variables.	$3 + \square + \square = 7$** $2 \times \square \times \square = 18$	Concrete
13–16	Two operations, one unknown variable.	$\square = (9 - 4) + 7$ $\square = (6 \times 8) \div 4$	Concrete (Control)
17–20	Two operations, with rearranging.	$2 + \square = 3 + 3$ $2 \times 3 \times \square = 24$	Concrete
22, 24, 25, 28	Two operations, with rearranging; commutativity can be used to side-step algebraic manipulations.	$4 \times \square = 3 \times 4$ $6 + \square = 4 + 6$	Concrete
21, 23, 26, 27	Two operations, with rearranging, plus distraction of apparent commutativity.	$8 - 3 = \square - 8$ $10 \div 5 = \square \div 10$	Formal

** Subject instructed that the *same number* was to go into each box.

TYPES OF ITEMS USED IN TEST 3, EXPERIMENT II

Item Numbers	Description	Sample Items	Classification
1–4	One unknown operation.	$3\square 6=9$ $1\square 0=0$	Concrete
5–8	Two operations, one unknown.	$(3\times 5)\square 5=10$ $(3\square 6)\div 3=6$	Concrete
9–12	One unknown operation, used twice.	$(2\square 2)\square 2=6$* $(2\square 2)\square 1=4$	Concrete
13–16	Two unknown operations.	$(4\square 2)\square 3=2$ $(6\square 5)\square 3=3$	Formal
17–20	Two unknown operations, response " same " or " different " required.	$6\square 3=7\square 4$ $9\square 4=16\square 3$	Formal
21–24	Two unknown operations, one unknown variable, response " same " or " different " required.	$n\square 3=n\square 6$ $n\square 2a=n\square a$	Formal

* Subjects instructed that the same number had to go into each box.

TYPES OF ITEMS USED IN TEST 4, EXPERIMENT II

Item Numbers	Description	Sample Items	Classification
1–4	One operation in each expression, small numbers.	$\frac{4}{2}, \frac{8}{4}$ $6\times 5,\ 3\times 10$	Concrete
5–8	Two operations in each expression, or large numbers.	$\frac{6\times 4}{2}, \frac{6\times 8}{4}$ $\frac{100\times 30}{70}, \frac{100\times 60}{70}$	Formal
9–12	Two operations in each expression, with unknown variables.	$\frac{a\times b}{c}, \frac{a\times 2b}{2c}$ $\frac{a\times b}{c}, \frac{3a\times 3b}{6c}$	Formal

RESULTS AND DISCUSSION

The proportion of correct responses, together with a summary of the statistical analysis, is shown in Table 2. Age trends and specific grade contrasts were computed for each set of items separately, using the SPSS programme. Data were missing for Grade 4 on Items 17 to 24 of Test 3, owing to inability of the children to perform these tasks.

On Test 1 the only items which gave difficulty were those which were predicted to be formal, i.e. Items 21, 23, 26 and 27. These items are essentially the same as Items 25, 27, 30 and 31 in Test 1, Experiment I. Grade 5 children perform at a level comparable with that of Class 5 children in the Australian sample, but the performance of Grade 8 is somewhat below that for the Form 1 children in the Australian sample, their nearest equivalent. It is possible that the low socio-economic status of the particular Canadian sample used has produced relatively lower levels of performance

TABLE 2

PROPORTION OF CORRECT RESPONSES FOR EACH SET OF ITEMS AT EACH GRADE LEVEL IN EXPERIMENT II

	Test 1							Test 3						Test 4		
	1–4	5–8	9–12	13–16	17–20	21, 23, 26, 27	22, 24, 25, 28	1–4	5–8	9–12	13–16	17–20	21–24	1–4	5–8	9–12
Means																
G4	·76	·61	·45	·70	·74	·01	·87	·67	·65	·64	·19	—	—	·71	·26	·17
G5	·88	·82	·71	·90	·83	·28	·92	·81	·79	·75	·45	·54	·42	·81	·47	·17
G6	·96	·90	·70	·91	·84	·45	·86	·90	·75	·76	·55	·67	·59	·80	·53	·45
G7	·99	·83	·75	·93	·98	·45	·96	·89	·94	·95	·64	·83	·78	·95	·56	·45
G8	·95	·85	·82	·88	·95	·48	·97	·90	·87	·88	·65	·72	·67	·90	·58	·29
Total	·90	·79	·67	·85	·86	·31	·92	·83	·79	·79	·48	·69	·62	·83	·47	·29
Age Trends																
Linear	·000	·001	·001	·01	·001	·001	NS	·001	·002	·001	·001	·01	·001	·001	·001	·001
Quadratic	·000	·002	NS	·01	NS	·05	NS	·05	NS	NS	·05	·05	·02	NS	NS	·001
Cubic	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	·005
Grade Contrasts																
4 & 5 *vs* 6, 7, 8	·001	·001	·001	·01	·001	·001	NS	·001	·05	·001	·001	·02*	·001*	·002	·001	·001
4 *vs* 5	·02	·001	·001	·01	NS	·001	NS	NS	NS	NS	001	—	—	NS	·005	NS
6 *vs* 7 & 8	NS	NS	NS	NS	·05	NS	NS	NS	NS	·05	NS	NS	·05	·05	NS	NS
7 *vs* 8	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	·05

* Grade 5 *vs* 6, 7, 8

as children get older. In absolute terms, this level of performance does not differ significantly from 50 per cent, the minimum performance expected of formal operational children.

The low level of performance on the items predicted to be formal is not matched on the items which were designed as controls. Performance on Items 13 to 16 is essentially the same as on the simplest concrete level items, showing that performance on the formal operational items is not attributable to inability to perform the necessary arithmetic. Performance on Items 17 to 20 shows that it was not the rearranging process which was the source of the difficulty on the formal items. As in Experiment I, performance was very high on items in which the need to find a new expression could be circumvented by using the commutativity principle. Clearly even the youngest children have a good knowledge of this principle.

On Test 3 performance for all groups is above 50 per cent on Items 1 to 12, which are predicted to be concrete. On the formal items performance is below 50 per cent for grades below 6, with the exception of Grade 5 performance on Items 17 to 20, which is 54 per cent. This is broadly consistent with the hypothesis that children under 11 do not succeed on items which require two operations to be matched simultaneously to the problem as presented. Performance is over 50 per cent on all items for Grades 6, 7 and 8, consistent with the hypothesis that children over 11 can handle a composition of binary operations.

On Test 4 performance is high for all grades on Items 1 to 4, consistent with the prediction that these items are concrete. The 50 per cent success rate is not passed until Grade 5, however, on Items 5 to 8, which are considered to be formal. Items 9-12 proved considerably more difficult, and mastery is not achieved in any of the grades sampled.

An interesting feature of the results is the levelling off of performance after Grade 6, as shown by the lack of significant differences between Grades 6, 7 and 8. On the concrete items this is probably a ceiling effect, but it occurs on most of the formal items too; and on Test 1, Items 21, 23, 26 and 27, and on Test 4 Items 9 to 12, it certainly could not be a ceiling effect. Given the depressed rural environment from which most of the sample came, it is more likely that there was a termination of cognitive development at a relatively low level for a substantial part of the sample.

GENERAL DISCUSSION

The single hypothesis most consistent with the overall pattern of results in these two experiments is that between the approximate ages of 5 and 10 years children are able to match a single binary operation to a problem, whereas after 11 years they are able to match two operations simultaneously to a problem. In the case of Test 1 there exists the alternative explanation that the younger children might have been distracted by the apparent applicability of the commutativity rule, with which they are clearly highly familiar. However, this explanation would not handle the results of Test 3. The formal operational items in Test 1 are analogous to Piaget's conservation tasks in this respect in providing a distracting cue to determine whether the children can decide which rule is logically appropriate to the situation. In this respect the task is subject to the same criticisms which are made of the conservation task, in that the reason for failure is difficult to determine (Braine, 1962).

A study by Collis (1975) supports the interpretation offered here. Collis trained children to determine the result of adding or subtracting units from the terms of addition and subtraction sums. For instance, if $a+b=c$, then $(a-1)+(b-1)=c-2$, whereas if $a-b=c$, then $(a-1)-(b-1)=c$. Concrete level children could learn the task if only one operation was involved, irrespective of whether that operation was addition or subtraction. When both operations were involved, the task could be learned only by formal level subjects.

The implications of the present study are that the younger age group can be regarded as concrete operational and the older group as formal operational in a sense which is different from, but certainly not inconsistent with, Piaget's meaning of these terms. It would not mean that children must first learn to conserve before mastering the concepts which are here categorised as concrete, nor that children must perform successfully in Inhelder and Piaget's (1958) various tests of formal operations before mastering the problems which depend on a composition of binary operations. It would mean that all of the problems which are considered concrete operational, including the mathematical problems considered here, are mastered at approximately the same time in the child's development because of a common level of difficulty, and similarly that all formal operational tasks are mastered at approximately the same age for the same kind of reason. There is no reason to suppose that the different tasks must be mastered synchronously or in any defined sequence. As Halford and Keats (1978) have pointed out, the question of the intercorrelations among different tasks is essentially irrelevant in terms of this approach.

One of the aims of this paper is to try to define the factor responsible for the level of difficulty common to all the tasks which are categorised as concrete, or formal. Elsewhere (Halford, 1978b) it has been proposed that where a system of elements is defined in sets of *n*, 2*n* chunks of information will be required for the system to be related to the environment in a consistent way. The elements of a Level 1 system are defined in sets of one; i.e. each element is defined by relation to another element (S→S). Level 2 systems have elements defined in sets of two, so that pairs of elements are defined by relation to (mapped into) one element (S,S→S). Level 3 systems have elements defined in sets of three; i.e. three elements are defined by their mapping into an element of the system (S,S,S→S). This implies that in order to learn a Level 1 cognitive system and apply it consistently to the environment the subject must be capable of holding two chunks in short-term memory store simultaneously. A similar performance with a Level 2 system will require four chunks, and with a Level 3 system six chunks. Using a specially-constructed learning set task, evidence has been provided that information processing demands as defined above do influence learning in the predicted manner. That is, Level 2 systems are considerably more difficult for 4-year-old children than for 5- and 6-year-olds, which is not the case with Level 1 systems. Similarly, Level 3 systems discriminate between 8- and 10-year-old children as against 11- and 13-year-olds, whereas Level 2 tasks do not (Halford, 1978b).

Given a suitable measure of information-processing capacity, it should be possible to predict the minimum age of mastery for each level of task. The best-available measure is probably the memory span norms for a standard intelligence test such as the WISC. From this we can predict that Level 2 tasks could be mastered by approximately 25 per cent of 5-year-olds, 50 per cent of 6-year-olds, and 90 per cent of 8-year-olds. Level 3 tasks could be mastered by 20 per cent of 8-year-olds, 50 per cent of 11-year-olds, and 75 per cent of 13-year-olds. Notice that gradual rather than abrupt emergence is predicted since the proportion of the population who has the necessary memory span will increase gradually with age.

The process of matching a system of symbols to a problem is basic to thinking. Craik (1943) hypothesised that thought could be conceptualised as translation into a model, operation on the model to determine an answer, then retranslation back to the terms of the problem. The structural relations among mental symbols in effect constitute the 'model' to which Craik refers. However, the model or symbol system must be matched to the problem in such a way that the structure of the model is consistent with the structure of the problem. Consistency is defined here by commutativity in the sense in which a category is commutative (Maclane, 1971).

Of course, these considerations represent only one aspect of the difficulty of a problem. Another is the form in which the problem is presented. For instance, all three-term series problems are at the same basic level of structural complexity, since all depend on the binary operation of transitivity. In terms of the argument of this paper, they should all be ultimately concrete operational, as the evidence of Rosenthal (1977) suggests they are. However, the form in which the problem is presented will still have considerable influence on solution rates. Another example is the four-card problem of Wason (1966), which can vary greatly in difficulty according to the mode of presentation (Lunzer *et al.*, 1972), as can the problem of detecting correlations (Smedslund, 1963; Seggie and Endersby, 1972).

The minimum difficulty level of a problem, beyond which it cannot be made simpler, will depend on the simplest system needed to represent adequately the relations among the problem elements. A system which is a composition of binary operations cannot be reduced to a single binary operation, nor can a binary operation be reduced to a binary relation. In so far as a problem has structural features which cannot be reduced to simpler systems, there will be a minimum difficulty level irrespective of mode of presentation. It is only this aspect of problem difficulty which can be related to the distinction between concrete and formal operational systems. Since much of the difficulty of mathematical problems depends on the form of the problem rather than on the structural complexity of the problem, it follows that cognitive developmental theory in the sense in which the term is used in this paper can account for only a part, and probably a small part, of the total variance due to mathematical problem difficulty. It is important that this criterion should be available to specify what can and cannot be predicted from cognitive developmental theory.

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PLAY AND NON-PLAY TUTORING IN PRE-SCHOOL CHILDREN: IS IT PLAY OR TUTORING WHICH MATTERS?

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SUMMARY. Despite interest in whether play is important in learning and development, little firm evidence exists. Some recent experimental studies have shown that encouraging fantasy and sociodramatic play in pre-school children may lead to gains in many wider aspects of competence. These gains have been ascribed to the increase in play. A critical analysis of this work reveals that insufficient control for the tutoring experience was used; competence gains may have been due to the adult contact in tutoring rather than to the play *per se*. A study is reported in which observations of both play and skills tutoring revealed that the conditions were matched for tutor verbal contact. In these circumstances, differential advantages to the play-tutored children were few, and were quite specific to sociodramatic play experience. It is suggested that the most parsimonious explanation of the previous studies is that most of the differential gains in wider aspects of competence were due to differences in the quality or quantity of tutor–child interaction.

INTRODUCTION

THE specific importance of play in the development of competence is still a major unresolved question facing educational and developmental psychology. It is a widely held view that play is a useful, if not essential, activity for many forms of learning. This view has strongly influenced pre-school educational practice, and has a long history of support in developmental psychology (Bruner, 1973). However, it is also possible to hold the view that non-playful practice could serve equally well in furthering the acquisition of skills (Loizos, 1967). From a Piagetian viewpoint, indeed, play is regarded as largely or purely assimilative, and therefore lacking in accommodative functions. The cognitive importance of play is thus very limited in Piaget's framework, although Piaget does ascribe an ego continuity function to playful activity (Sutton-Smith, 1966; Piaget, 1966).

Considering the salience of the topic, hard empirical evidence bearing on the function of play in human learning and development is remarkably slight (see reviews in Bruner *et al.*, 1976; Tizard and Harvey, 1977).

Possibly the strongest body of evidence which apparently argues for the importance of play experience in learning relates to fantasy play and sociodramatic play in pre-school children. Smilansky (1968) in particular put forward the view that sociodramatic play helped develop creativity, intellectual growth and social skills in young children. She provided little direct evidence to support this, but it has been an influential perspective in subsequent research. Smilansky also drew attention, on the basis of firmer evidence, to the lower levels of sociodramatic play observed in disadvantaged children, and to the potential of play-tutoring by adults for encouraging more complex spontaneous play ability subsequently.

Further work has confirmed that the fantasy and sociodramatic play of disadvantaged children (i.e. children with a likelihood of poor educational achievement predictable from home background circumstances) is less frequent, and less complex, than that of others in certain respects (Rosen, 1974; Tizard *et al.*, 1976; Smith and Dodsworth, 1978). It has also been confirmed that play tutoring—intervention by an adult to encourage fantasy and sociodramatic play—results in more such play, and at more complex levels, after the intervention (Marshall and Hahn, 1967; Feitelson, 1972; Freyberg, 1973).

These findings have in turn led back to research into the possible functional importance of these kinds of play. Two main kinds of evidence are available in the literature. The first kind, and decidedly the weaker, is evidence correlating play levels with competence measures. For example, a report by Johnson (1976) on 3- to 5-year-old children indicated that the frequency of social fantasy play correlated positively with certain cognitive abilities, even with age partialled out. Similar kinds of correlational evidence are available from Smilansky (1968), Helen-Lewis (1972), Singer (1973), and Becher and Wolfgang (1977). No cause and effect relations can be determined from these data, which are equally compatible with high play levels helping to cause high competence levels, or with high play levels being the affective expression of high competence levels. The actual importance of the play cannot be inferred.

A stronger source of evidence results from experimental studies which have utilised the findings on the efficacy of play tutoring mentioned earlier. The general design of such studies is summarised in Table 1. It can be expected that if an experimental group receives play tutoring, this will increase levels of spontaneous play more than occurs in a control group. If the experimental group also shows greater gains on wider measures of competence, such as linguistic, cognitive or social skills, or creativity tests, then it is inferred that the increase in spontaneous fantasy or sociodramatic play can be held causally responsible for this.

An appreciable number of such studies have now been reported, all carried out with pre-school children, usually from educationally disadvantaged backgrounds, in the USA. These are summarised in Table 2. The results have generally been positive, in that increases in fantasy play or sociodramatic play in the experimental groups have been associated with increases in associative play generally, and in wider aspects of competence such as creativity, positive affect, concentration, language skills, group construction and co-operation, role-taking skills, IQ scores, and conservation of quantity.

These studies have essentially been examples of *product* rather than *process* research. Very little is reported on the actual tutoring and control conditions used. On the basis of a product-oriented analysis, it is usually inferred that the greater increase in spontaneous play levels themselves, as found in the post-test assessment, is responsible for the differential increase in wider aspects of competence in the play-tutored (experimental) group.

However, this inference can only have validity if the different experimental and control intervention conditions are meaningfully equated for aspects other than the encouragement of play (see Smith, 1977, for an earlier review). This critique is most applicable to Lovinger's (1974) report, in which the control group received no extra intervention from an adult. The experimental group by contrast received much individual adult intervention in the play tutoring sessions, and this in itself would be likely to boost linguistic competence in the children, irrespective of the playful or non-playful nature of the interaction.

The other studies did involve one or more control groups which experienced extra interaction with an adult of some kind or another. However, no measurements were made of the amount or kind of interaction with the tutor in the different conditions, so the control, being based at best on gross time available, is not a satisfactory one. It is not clear that children receiving music tutoring (Feitelson and Ross, 1973), for example, are meaningfully equated with play-tutored children. Differential improvement of competence by children in the play tutored groups may be due to qualitative and quantitative differences in adult contact in the tutoring, rather than to the differential increase in play levels.

Two bits of evidence lend credence to such a supposition. First, Saltz and

TABLE 1

SCHEMATIC DESIGN OF PREVIOUS STUDIES AND PRESENT STUDY ON PLAY AND NON-PLAY TUTORING WITH PRE-SCHOOL CHILDREN

Subjects	Pre-test	Intervention conditions	Post-test
Experimental group(s)	Levels of spontaneous play	Play-tutoring experience	Levels of spontaneous play
Control group(s)	Measures of competence	Non-play tutoring or non-tuition experience	Measures of competence

TABLE 2

PREVIOUS EXPERIMENTAL STUDIES WITH GROUPS TUTORED FOR FANTASY PLAY (FP), THEMATIC FANTASY PLAY (TFP), OR SOCIODRAMATIC PLAY (SDP): SUMMARY OF CONTROL CONDITIONS, AND RESULTS

Reference	Experimental and control groups	Significant results*†	Non-significant results†
Marshall and Hahn, 1967	(1) FP tutoring (2) Non-fantasy tutoring (3) No treatment	Dramatic play language and aggression; Associative play (1) > (2), (3)	Friendly approach/ response; conversation; aggression
Feitelson and Ross, 1973	(1) FP tutoring (2) Toys only (3) Music tutoring (4) No treatment	Higher levels of play; Torrance originality (1) > (2), (3), (4)	CATB: dog-and-bone, task initiation, curiosity box. Torrance fluency and flexibility
Fink, 1974	(1) SDP tutoring (2) Toys only (3) No treatment	Imaginativeness in play; Divergent thinking; Social perspectivism; Conservation of social role (1) > (2), (3)	Conservation of number; Conservation of quantity; reversibility; physical perspectivism.
Freyberg, 1973	(1) FP tutoring (2) Puzzle toy tutoring	Imaginativeness in play; Positive affect and concentration (1) > (2)	
Lovinger, 1974	(1) SDP tutoring (2) No treatment	Complexity of play; ITPA verbal expression; number of words and sentences (1) > (2)	
Rosen, 1974	(1) SDP tutoring (2) Non-fantasy tutoring	Sociodramatic play; Torrance group construction; Madsen cooperation board; Flavell perceptual and preferences role-taking (1) > (2)	Kuethe social distance task
Saltz and Johnson, 1974	(1) TFP tutoring (2) Dimensionality training (3) = 50% (1) + 50% (2) (4) Listen to stories	Fantasy play; (1), (3) > (2), (4) Subscales of WPPSI and ITPA (1), (2), (3) > (4)	
Saltz, Dixon and Johnson, 1977	(1) TFP tutoring (2) SDP tutoring (3) Fantasy discussion (4) Non-fantasy activity	PPVT and PTI (1), (2) > (3), (4)	
Golomb and Cornelius, 1977**	(1) Pretence play tutoring (2) Construction play tutoring	Conservation of quantity (1) > (2)	

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* Significant at ·05 level or beyond.

† Only measures on which pre- and post-assessment was made are summarised.

** No measures of spontaneous play were made in this study.

Johnson (1974), who perhaps had the best non-play tutored controls, found no differential improvement on the WPPSI and ITPA. Secondly, in Rosen's (1974) study, one of the four classes of children contained rather more from middle-class backgrounds. Predictably, this class had higher initial levels of sociodramatic play, but, less predictably, their initial scores on the group tasks and role-taking skills were not higher. This is difficult to account for, if it is play skills rather than tutoring experience which are important in the task score improvements.

If this critical supposition is correct, then it would be expected that if the play tutored and non-play tutored groups were reasonably equated for the amount and kind of adult contact involved in tutoring, then both groups would increase equivalently in competence scores while only the play tutored group would increase substantially in play scores. This would not be the case if the play in itself was important, rather than or in addition to the tutoring.

The ensuing study was designed to test these two alternatives with respect to measures of competence similar to those employed in some of the earlier studies. Detailed observations of the processes of play and non-play tutoring conditions were made, in order to ascertain how comparable they were in amount and kind of contact with the children. The non-play tutored group was designated a skills tutored group, rather than a control group, with the implication that two different treatment conditions, initially conceived of as having equal status, were being compared.

METHOD

Sample

Children were selected from a pre-school playgroup in Merseyside. Parents were contacted and, from a pool of 26 children volunteered, 14 were selected to take part in the project. Selection was to give two groups of seven children, matched for age, sex and social background. Each group contained four boys and three girls, four being 4 years old and three 3 years old. The parents were of skilled working class and lower middle class backgrounds.

Project design

The project was carried out from July to September, 1976. For a two-week period in July the children were assessed for levels of spontaneous play and social participation, and on various measures of competence, while all attending the same playgroup. During the summer vacation each group of children separately attended a five-week course run by two qualified tutors, in which one group received play tutoring and the other group received skills tutoring. Systematic observations of tutor–child interactions were made. When the regular playgroup started again in September final assessments were made of the same play and competence measures as were assessed initially.

Pre- and post-assessments

Observations of play and social participation were made during six one-hour free play sessions in the playgroup, before and after the tutoring. Scan sampling (Altmann, 1974) at two minute intervals was used. At each interval the 14 subject children were observed rapidly and sequentially. For each child a decision was first made as to whether he or she was engaged in some activity, or doing nothing. The latter was scored as *no activity*, meaning the child was unoccupied, perhaps just watching other children or fumbling an object repetitively. One session of simultaneous recording with a second observer gave a concordance (no. of agreements/(no. of agreements + no. of disagreements)) of 0·95 for this category. If the child was engaged in some activity, it was classified as fantasy or non-fantasy. *Fantasy activity* was scored for any clear evidence of make-believe elements in actions, object use or verbalisations.

Simple use of a representational object, such as pushing a toy car, or carrying a doll, was not so scored without additional evidence, e.g. making car noises, tucking the doll in bed. Concordance was 0·95. *Non-fantasy activity* was scored for any activity not involving fantasy elements. Concordance was 0·96.

If a child was engaged in some activity then the degree of social participation involved was also assessed, as either *solitary*, *parallel* or *group*. These terms are as defined in Smith and Connolly (1972), being slight modifications of Parten's (1932) original classification. Concordances were 1·00, 0·97, and 0·95 respectively.

Five kinds of test assessment were made for each child. These were:

(*a*) sections of the Reynell Language Development Scale, namely the verbal comprehension scale ' A ', and the vocabulary and content sections of the expressive language scale;

(*b*) the Caldwell Co-operative Pre-School Inventory, measuring knowledge of basic concepts;

(*c*) the Goodenough-Harris " Draw-a-man " test, the children being required to draw a picture of a man, a woman, and themselves;

(*d*) the " Dog and bone " test of creativity (Banta, 1970); the child is required to trace as many routes as possible which a dog can take through rows of houses to reach a bone;

(*e*) two role-taking preference tasks similar to those of Rosen (1974), adapted from Flavell *et al.* (1968). In one, the child was helped to identify photographs of a shirt, high-heeled shoes, doll, toy garage, and cat basket, and then asked to choose a suitable present for him/herself if he/she was a mother, father, little boy or little girl. In the second, a child was shown photographs of a policeman's helmet, postbox, firehose, stethoscope and garden fork, and asked which he/she would use as a policeman, postman, fireman or doctor. Scoring was as in Rosen (1974).

Tutoring sessions

The tutoring sessions took place in the house and gardens of a private residence. Each group of seven children attended three times a week over five weeks, totalling 15 sessions. Two adults, both with previous pre-school experience and qualifications, supervised the children in free play activities in which little adult involvement occurred. In addition, they provided tutoring for one 40-minute period in each session, each contributing equally to the play-tutoring and skills-tutoring interventions.

In play tutoring sessions, the tutor aimed to initiate and maintain fantasy play in the children. This was generally done by providing a theme and suitable materials, and encouraging children to join in. Typical themes were ' going to the seaside ', ' the farm ', ' the circus ', ' Christmas ', ' doctors ', ' lion hunting '.

In skills tutoring sessions, the tutor aimed to encourage activities with some definite end product in mind. For example clay modelling, shape printing, painting, collage work, construction and number games, making cakes and jellies, and games involving concepts of colour, shape, size and position were used.

The tutors were asked to attempt roughly equal levels of interaction in the two conditions. They were otherwise unaware of either the theoretical rationale of the study or the assessment procedures.

Attendance of the subject children was high in both groups—92 per cent in the play tutored group, and 95 per cent in the skills tutored group. No child attended fewer than 12 of the 15 sessions. Two additional pre-school children (one a daughter of one of the tutors, the other a male friend) also attended both the groups, but were not observed or assessed.

Observations of tutoring sessions

At every tutoring session the tutor was observed continuously for the 40-minute period. Each utterance, and attention to a child using objects (including pretend objects), was categorised using a coding scheme adapted from Hutt (1974). Each tutor utterance to a child was classified as *statement/comment*, *explanation*, *command*, *suggestion*, *question/request*, *yes/no reply*, *answer*, or *approbation*. Each object activity directed to a child was categorised as *give*, *take*, *show* or *help*. In each case the name of the child to whom the attention was directed was noted. In addition, *non-specific verbal* and *object* contacts directed to the whole group were also recorded.

All the observations were made by one observer using a check-sheet. Simultaneous recording with an independent observer through one 40-minute session showed that the Spearman correlation coefficient between observers, over the 13 specific contact category totals, was $r(11) = 0{\cdot}79$, significant at $P < {\cdot}001$.

RESULTS

Quantity and quality of tutor contact

The total number of contacts to specific children did not differ significantly between the two groups (see Table 3). In particular, there was no appreciable or significant difference in the amount of verbal contact, on an independent groups *t* test. The quality of verbal contacts was also largely similar, except that the play tutored group received more *suggestions*, while the skills tutored group received more *explanations* and *approbations*. There was a significant difference in object contacts, the skills tutored group receiving many more object contacts both overall, and of each individual type.

TABLE 3

MEANS FOR CATEGORIES OF TUTOR CONTACT TO SPECIFIC CHILDREN, FOR PLAY-TUTORING AND SKILLS-TUTORING SESSIONS. SIGNIFICANCE LEVELS FROM INDEPENDENT GROUPS t TESTS

Category	Play-tutoring	Skills-tutoring	t (12)
Statement/comment	12·0	9·3	0·91
Explanation	0·1	2·4	3·44*
Command	2·3	3·1	0·32
Suggestion	10·9	3·3	5·05***
Question	91·7	73·0	1·75
Request	83·1	65·7	0·99
Yes/no reply	0·9	1·4	0·91
Answer	22·4	24·9	0·31
Approbation	3·6	30·4	11·30***
Give object	10·3	34·7	7·49***
Take object	3·1	6·7	3·95**
Show object	1·0	5·9	6·89***
Help with object	0·4	4·6	4·39***
Total verbal contacts	227·0	213·6	0·33
Total object contacts	14·9	51·9	9·76***
Total overall contacts	241·9	265·4	0·61

* P<·05 ** P<·01 *** P<·001

Results were also obtained for non-specific contacts addressed to the whole group. Of these there were 624 verbal contacts and 43 object contacts to the play tutored group, and 629 verbal and 259 object contacts to the skills tutored group. This reinforces the general picture of no overall difference in verbal contacts, but the skills tutored group receiving appreciably more object related contacts from the tutor.

Pre- and post-scores on play and competence measures

Results for all the play and competence measures were analysed using a two-way analysis of variance, the factors being tutoring group (2 levels) and pre- and post-scores (2 levels). Thus interaction effects would reveal a differential increase in one group over the other. The results are shown in Table 4.

Most of the overall differences between the two groups were slight, although the children in the skills tutored group did show more *solitary* activity. In general, the pre-test scores were fairly well matched.

Predictable changes occurred for both groups in the eight-week interval which separated the pre- and post-testing. The children in both groups were observed in more *group* activity in free play, in more *fantasy activity* and less often in *no activity*. Also scores on all five of the tests improved significantly.

In general the play tutored and skills tutored groups improved fairly equally on all the measures. However the play tutored group, as was expected, increased their *fantasy activity* in free play, after the intervention was over, more than the skills tutored group. They also showed a differential increase in *group* activity in free play.

TABLE 4

MEAN PRE- AND POST-TEST SCORES ON PLAY AND COMPETENCE MEASURES. FOR EACH CATEGORY, SCORES FOR PLAY-TUTORED GROUP ABOVE SCORES FOR SKILLS-TUTORED GROUP. SIGNIFICANCE LEVELS FROM ANALYSIS OF VARIANCE

Category	Pre-test	Post-test	F (1, 12) values		
			Group	Time	Group × Time
Fantasy activity	12·7	51·5	1·74	54·66***	18·13**
	14·8	25·2			
Non-fantasy activity	61·8	42·0	1·55	4·34	2·01
	65·0	61·2			
No activity	25·5	6·5	0·02	8·11*	1·86
	20·3	13·6			
Group activity	25·9	56·9	0·88	19·01***	9·39**
	30·0	35·4			
Parallel activity	41·7	31·3	0·01	0·50	2·54
	35·4	39·4			
Solitary activity	6·9	5·4	8·24*	2·54	0·20
	14·3	11·6			
Reynell Language	24·3	29·1	0·99	4·99*	0·55
	23·0	25·4			
Caldwell Inventory	31·9	45·3	2·79	95·04***	0·94
	38·6	49·6			
Draw-a-man	9·6	14·4	2·56	14·03**	0·00
	17·6	22·3			
Dog and bone	2·1	4·7	0·94	144·40***	0·40
	1·4	4·3			
Role-taking	4·9	7·0	0·05	16·76**	7·45*
	5·6	6·0			

* P<·05 ** P<·01 *** P<·001

There was no differential increase by either group on the Reynell Language Scales, Caldwell Co-operative Pre-school Inventory, Goodenough Harris Draw-a-man test, or the Dog-and-bone test. However the play tutored group did increase more on the role-taking preference tests, the trend being present for both the ' presents ' and ' occupations ' subtests.

DISCUSSION

The results suggest that the project succeeded in providing a fairly close match between the two tutoring conditions as regards the overall number of tutor contacts to the children. This holds true particularly for verbal contacts, the skills tutored group receiving more contacts in connection with object use.

The two groups of children were closely matched for age and sex composition, and in pre-test scores on most measures. As expected, both groups increased their test scores after the interventions, and also the amounts of group activity and fantasy activity in free play, with fewer records of no activity. These results may be largely attributable to the tutoring interventions, although effects of age and more general experience are not controlled for in the design.

The main interest in the results is on the differential effects of the treatment conditions. Only three measures out of the eleven in Table 4 revealed a significant differential effect. These were all in favour of the play tutored group. That these children would differentially increase amounts of fantasy play was predicted from previous work, and is implicit in the idea of play tutoring. It is notable that the other two differential effects are fairly closely related to this.

Much of the fantasy activity encouraged in the play tutoring group during the tutoring sessions was sociodramatic play involving several children, and this also constituted most of the increase in fantasy play in the free play observations. The differential increase in group activity is thus partly attributable directly to this. In contrast, the skills tutored children were encouraged more in tasks which only required solitary or parallel activity, such as painting or constructional toys.

So far as general language and cognitive abilities are concerned, the evidence is that both groups improved equally well. Only on the role-taking preference tests did the play tutored group show a differential gain. Here again the abilities required are closely related to those which would be practised in the role-playing and fantasy of the play sessions.

This pattern of results points to some re-interpretation of the conclusions of earlier studies reviewed in the introduction. The differential advantages ascribed to play tutoring in the realms of language and cognitive skills (Lovinger, 1974; Saltz *et al.*, 1977) and creativity (Feitelson and Ross, 1973) may be due to a lack of adequate control for tutor contact in the non-play tutored or control groups. If this is controlled for, the actual advantages to play tutored children may be limited to fantasy play level in itself, and to measures of competence or ability quite closely or specifically related to this, such as associative (group) play and role-taking skills.

This generalisation is a tentative one, given the small number of children in the present study. It is also possible that other measures of competence, such as attention span for example, might differentially favour skills tutored groups. A fuller and more satisfactory way of assessing creativity would be desirable. Further work in this area could usefully embody such suggestions, as well as including follow-up observations of the children to examine how well any competence gains are maintained once intervention has ceased. What is clear is the importance of closely monitoring and recording the tutor's attention to and contacts with the children in any such investigations. Specific advantages to play tutored groups cannot be ascribed to improvements in play levels *per se* without such detailed control. Thus although Saltz *et al.* (1977)

claim to reject a ' verbal stimulation ' model explanation of their findings, no process analysis of any kind is available to support their contention that either quantity or quality of verbal stimulation was equated for in their play and non-play tutored groups.

It is a tenable hypothesis that many or most of the results summarised in Table 2 are due to the tutoring aspect of play tutoring, rather than the play aspect. This does *not* mean that play tutoring is not worthwhile. It quite clearly seems to have results as good as or better than non-play tutoring. However, this is quite possibly because of the close adult–child interaction involved in such tutoring sessions. These studies have not yet pointed unambiguously to the value of spontaneous fantasy or sociodramatic play in pre-school children for general cognitive, linguistic or social learning.

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EXPECTANCY AS A FUNCTION OF SEX, GRADE, FEEDBACK LEVEL AND PERFORMER

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SUMMARY. Accuracy of expectation for oneself and for another person was assessed on a perceptual judgment task given to 60 children from each of three grades—first, third and fifth. Significant main effects of Grade and Feedback Level were observed, whereas the significant Performer (self *vs.* other) main effect was confounded by a Grade × Performer interaction. Older children were more accurate than younger, high feedback students more accurate than low and other judgments were more accurate than self at the fifth-grade level. The Sex difference main effect was non-significant.

INTRODUCTION

DESPITE the central role of expectancy in contemporary social learning theories (e.g., Rotter's social learning and Atkinson's need-achievement approaches), many group differences in expectation and aspiration have not been clearly delineated. Whereas Crandall's (1969) summary indicated that males tend to state unrealistically high expectations relative to females, later research has more frequently resulted in non-significant sex differences (Roseman, 1974; Clifford, 1975). Developmental difference analyses tend to support the finding that older children state high but realistic expectations and younger children state unrealistically high or low expectations, usually the former (Reidel and Milgram, 1970; Roseman, 1974; Clifford, 1975). Little has been done comparing the effect of manipulated high *vs.* low feedback on the accuracy of subsequent expectations of children, although Crandall indicates that high feedback students spend more time at subsequent tasks relative to low and might, therefore, tend to state more accurate expectations. It was predicted in the present study that older children would be more accurate than younger, and high feedback students more accurate than low, in stating expectations. No sex difference prediction was made due to conflicting data.

It may be the case that group differences in expectancy do not reflect an inability to formulate accurate expectancies but rather reflect such confounding factors as demand characteristics of the situation. If children 'know' more accurate self expectancies than they publicly state, one might expect that such children would be more accurate in stating expectancies for unknown other people than for themselves, a tendency McGehee (1940) observed in adult behaviour.

METHOD

Sample

The children tested were from the state of Iowa—63 first graders (34 males, 29 females), 61 third graders (35 males, 26 females) and 78 fifth graders (47 males and 31 females)—a total of 202 students. One first-grade female was dropped for failing to follow instructions and two first-grade females, one third-grade male, five fifth-grade females and 13 fifth-grade males were randomly discarded to ensure proportionality of groups, leaving 180 children in the data analysis.

Materials

A novel perceptual judgment problem was used in this experiment to control for potential pre-experimental expectancy differences among children. Students were to decide which of three irregularly-shaped lines was longest for each problem. Ten problems were placed on each of five pages which were to constitute the booklets used in the first two segments of the experiment. All problems were insoluble since all three lines were of equal length for a given problem. A release task, consisting of easily soluble problems, was presented to the children toward the end of the experiment so that all children completed the study with a sense of task competence. A. B. Dick Latent Image Analyzers, similar to felt tip pens, were used to colour in a circle under the student's selection for each problem. A plus sign revealed in the circle indicated a correct response and a minus represented an error. Feedback was manipulated by putting all plus or minus signs under the appropriate problems.

Procedure

Data were collected in intact classrooms. The first part of the experiment involved a ' Self Task '. Self Task booklets were distributed and instructions were administered. Soluble sample problems were completed by the children, who then proceeded to complete the first four pages of the test booklets. Half of the students received feedback which averaged 7 of 10 correct over the four trial-pages (scores of 7, 8, 7, 6 respectively), and the other half received 3 of 10 correct as their average manipulated feedback (3, 4, 3, 2 respectively). At the end of the first four pages, the children were instructed to turn to the fifth page and indicate how many problems they ' expected ' or ' thought ' that they would correctly answer. The Self Booklets were collected with the fifth page unworked.

An ' Other Booklet ' was then given to each child with the first four trial-pages completed at the same performance level as that student had ' achieved ' on the Self Booklet (i.e. 3, 2, 4, 3 for low feedback and 7, 6, 8, 7 for high feedback). All personal information was ' blacked out ' on the Other Booklet to hide the age, sex, and other potentially confounding information from the child. The student was told that some other child had worked the booklet placed in front of him/her but that child had not predicted how he/she would perform on the fifth trial-page. Subjects inspected the four pages and were asked to predict how the other student would have done if he/she had worked the fifth page, which had the same problems as the fifth page of the Self Booklet. Once subjects had written the expectancy judgment on the fifth page, all booklets were collected. A release task consisting of easy line drawing problems was administered with all students scoring 80 per cent to 100 per cent on this task. Subjects were then asked a series of increasingly leading questions to assess the false feedback manipulation (none indicated awareness of the manipulation). After a 'debriefing ', subjects were excused.

The primary dependent measure was the absolute difference between children's written expectation on Page 5 and the average feedback on the four preceding trial-pages (Goal Discrepancy). This difference score was coded on a four-point scale with four representing perfect accuracy relative to prior feedback, three indicating a one-point discrepancy, two representing a two-point difference and one representing a discrepancy from previous feedback of three or more points in either direction. The four-point scale was an attempt to attenuate potential ceiling and basement effects in the two feedback conditions since high feedback children could overestimate by only three with opposite conditions operating for the low feedback students.

RESULTS

Cell means and standard deviations are presented in Table 1.

A four-way analysis of variance (Sex × Grade × Performer × Feedback Level) on Goal Discrepancy yielded significant main effects in the predicted direction for Grade ($P < \cdot 001$) and Feedback Level ($P < \cdot 001$). Older children were more accurate in stating expectations than younger and high feedback students were more accurate than low. The Performer main effect was also significant in the predicted direction ($P < \cdot 05$) but was confounded by an interaction ($P < \cdot 01$) with Grade. Non-significant differ-

TABLE 1

MEANS AND STANDARD DEVIATIONS FOR ABSOLUTE GOAL DISCREPANCY

Grade	Low Feedback		High Feedback	
	Male	Female	Male	Female
	(N = 17 per cell)	(N = 13 per cell)	(N = 17 per cell)	(N = 13 per cell)
1	Self 1·70/ ·98	Self 1·64/1·08	Self 2·05/1·08	Self 1·85/1·16
	Other 1·35/ ·75	Other 1·28/ ·60	Other 2·17/ ·95	Other 1·71/1·13
3	Self 2·23/1·34	Self 2·00/ ·81	Self 3·06/ ·85	Self 3·38/ ·65
	Other 2·35/1·16	Other 2·53/ ·96	Other 3·11/ ·78	Other 3·46/ ·63
5	Self 2·00/1·12	Self 2·18/1·16	Self 3·00/1·17	Self 3·20/1·08
	Other 2·56/1·30	Other 3·00/ ·96	Other 3·37/ ·87	Other 3·40/ ·63

ences between self and other Goal Discrepancies were observed on Scheffé *post-hoc* tests at Grades 1 and 3, with only the fifth-grade children being more accurate ($P < \cdot 01$) on the other relative to self task. No sex difference or other effects were significant in the overall ANOVA. Observation of the raw score data indicated that *all* groups overestimated relative to prior performance with significant effects resulting from the relative amount of overestimation.

DISCUSSION

While the non-significant main effect for Sex is difficult to interpret, it is interesting to note that Crandall's (1969) rather consistent sex difference findings have rarely been replicated in the 1970s (Clifford, 1975; Roseman, 1974). The retention of the null hypothesis in the more recent studies may be reflective of a decrease in sex role stereotyping which may have an effect on children's self expectations, academic and otherwise. The present methodology may be a good one to assess group differences in expectations since prior feedback is controlled via false feedback. Many studies of the relationship between expectancy and status variates such as sex, SES and race fail to control for prior experience or feedback on the relevant task between groups.

The significant main effect of Grade seems to be a stable datum. The next step for researchers appears to be an analysis of the causal agent(s) responsible for these effects.

The main effect of Performer is not surprising in light of McGehee's (1940) datum for adults. The observed interaction was not predicted and makes the observed main effect of Performer difficult to interpret. Perhaps the main effect and interaction can be explained if one assumes that the first and third graders were largely operating at Piaget's pre-operational level, which is characterised by an inability to distinguish one's own thought processes from another's (Piaget, 1948). It is only for the fifth-grade children who are clearly beyond the pre-operational age that one might expect the more adult distinction between self and other thought processes (expectancies) that McGehee (1940) observed. If the self-other difference on expectancy is replicable, it will be interesting to note the causal agent responsible. Demand characteristics of the situation and selective perception are two potential causes.

The Feedback Level main effect could be attributed to ceiling effects or by assuming that almost all children enter an academic task with the expectation of scoring at or above the high feedback level. The coded, four-point scale for Goal Discrepancy does not fully attenuate these problems and the scale truncation may result in the loss of psychologically and statistically important dependent variable information. Future researchers should be aware of this and potential reliablity problems associated with obtaining only one expectancy judgment from each child.

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VISUAL MOTOR SHORT TERM MEMORY IN EDUCATIONALLY SUBNORMAL BOYS

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SUMMARY. 45 ESN boys in three mental age groups of 6, 9, and 12 years were examined for developmental trends and rehearsal strategies on a visual motor short term memory task. Comparisons were made with 45 normal boys aged 6. 9, and 12. Developmental trends and rehearsal strategies were almost totally absent in ESN boys. Normal boys were superior to ESN boys when central processing space was available during a condition of rest. No differences were evident when central processing was prevented during an interpolated activity condition. It was concluded that normal–ESN differences could be attributed to lack of mnemonic strategies in the ESN boys.

INTRODUCTION

IT is well documented that on standardised tests of motor performance, mentally handicapped children perform well below the average of intellectually normal children of the same age and sex (Malpass, 1959; Rarick *et al.*, 1970; Rarick and Dobbins, 1972; Rarick and McQuillan, 1977). Most investigators of motor abilities have looked at the end product of the movement, or have evaluated the effects of perceptual motor training and physical activity programmes upon intelligence and academic performance (Oliver, 1958; Kephart, 1960; Corder, 1966). However, it may be more pertinent to discover the processes and strategies involved in the acquisition of skill than to study the end product of any movement. Work on information processing using both verbal and motor tasks, reflect this ' process ' rather than ' product ' approach, and it is here that short term memory investigations have played a prominent role.

Short term memory (STM) deficits have been outlined as one of the possible causes for the inferior verbal learning and performance of the mentally handicapped, and several theories have been proposed to account for these deficits (Ellis, 1963; Spitz, 1966). Belmont and Butterfield (1969) and Ellis (1970) reviewed studies and conducted their own research, concluding that very young children and the mentally handicapped do not spontaneously rehearse information like adults on STM tasks. Belmont and Butterfield summarised the work on serial lists and Brown (1973) extended their findings by using a task that did not require serial information.

Brown (1974) stated that it is customary to describe the mentally handicapped as deficient in the use of short term memory, but not long term memory. However, the major question seems to be whether, in fact, it is memory that is deficient, or the strategies that are used in memory tasks? To resolve this question it would be necessary to have two types of tasks, one allowing strategies and one preventing them, and then to investigate differences between normal children and the mentally handicapped. If a task demanded strategic transformations for its efficient execution, then such differences would be predicted. In a task where such strategies are not normally employed, or are prevented as in one condition in the present study, no differences would be predicted.

During the last ten years, short term motor memory (STMM) has emerged as an area of study, and comparisons with verbal memory have been made. Investigations have not been performed developmentally or across IQ ranges, but theories of STMM have emerged from work with adult subjects (Pepper and Herman, 1970; Laabs, 1973).

Most of the studies have used blindfolded subjects involving just kinaesthetic or motor memory. However, Posner and Konick (1966) and Posner (1967) investigated both visual and kinaesthetic processes in a motor task. These studies explored the role of central processing capacity in the retention of information arising from visual and kinaesthetic sources. The central processing notion was introduced by Broadbent (1958), who proposed that it is meaningful to talk about rehearsal in non-verbal form if it is shown to require a portion of the subject's processing space. The results of the Posner and Konick studies indicated that visual and kinaesthetic storage systems were affected differently by an interpolated task. The function of this task was to take up central processing space. Retention of visual information was greatly aided by the presence of central processing space. The authors concluded that visual information was being rehearsed, and this was demonstrated by the increased retention over time. Retention of kinaesthetic information was much less affected by the availability of processing space. The subjects could not sustain kinaesthetic information even over an unfilled interval. The presence of central processing space made relatively little difference. In a later study, Laabs (1973) proposed two separate memory functions for kinaesthetic information—kinaesthetic location information and kinaesthetic distance information. The former, which was the end position of the movement, was rehearsable as long as processing space was available. The latter, which was the distance travelled, seemed spontaneously to decay.

The implication of the studies on vision and kinaesthesis is that if vision is available, it is the modality that is used. In the present study, both vision and kinaesthetic location cues are present enabling rehearsal to take place if it is within the capabilities of the individual.

This investigation attempted to describe the developmental sequence of visual motor STM in ESN boys during conditions of rest and interpolated activity. Secondly, it explored whether the strategy of spontaneous rehearsal, absent on verbal and purely visual tasks, is utilised by ESN boys on a visual motor STM task. Finally, both development and rehearsal strategies of ESN boys were compared with normal boys.

METHOD

Sample

A total of 90 boys were selected to participate in this study: 45 of the boys were from three normal schools, 45 were from three schools for the educationally subnormal. All schools were situated in small towns on the outskirts of London. There were three groups of 15 boys in both the normal and ESN groups. The ages of the groups for the normal boys were 6, 9, and 12 years; the ESN boys were in mental age groups of 6, 9, and 12 years, that is, a mental age match with the chronological ages of the normal boys.

The boys from the normal schools were randomly selected from all ability ranges within their schools. The ranges of ages are shown in Table 1.

The boys from the ESN schools were randomly selected from a range of available boys in the school. Where possible, the lower range of IQs were taken in order to make comparisons with the literature concerning the category of educationally

TABLE 1

AGES OF NORMAL BOYS

Age Group	Range	Mean
Six	5·5–6·6	6·0
Nine	8·6–9·6	9·0
Twelve	11·6–12·6	12·0

mentally retarded in the U.S.A. The number of available boys who met the selection criterion was 21 for the 6-year-old age group, 24 for the 9-year-old age group, and 18 for the 12-year-old age group. Fifteen boys were then randomly drawn from each group. The IQs, chronological and mental ages are shown in Table 2.

TABLE 2

IQ, CHRONOLOGICAL AGE AND MENTAL AGE OF ESN BOYS

Group	IQ		CA		MA	
MA	Range	Mean	Range	Mean	Range	Mean
6	60–79	73	7·9–10·6	9·5	5·6–7·11	6·9
9	60–71	66	12·9–15·5	13·9	8·4–10·1	9·2
12	71–79	76	13·9–16·3	15·4	10·11–12·7	11·8

Apparatus

The apparatus consisted of two 1·9 cm alloy rods mounted parallel and horizontally with two near frictionless bushings joined together which slid along the rods. A handle was attached to the bushings so that the children could grasp it and move the bushing to a given location.

As vision was used in all testing conditions, it was necessary to eliminate visual cues which could be used to identify the location of the lever. A plain brown board 10 cm high was placed along the front of the apparatus, and one 30 cm high of the same material at the back. Only the handle was actually visible to the subjects. A blue pointer was placed on the top of the handle and a corresponding marker was attached to the back of the apparatus.

Design

All subjects performed four trials at each of the following conditions: 10 seconds rest; 10 seconds interpolated activity; 30 seconds rest; 30 seconds interpolated activity. Four lengths for the criterion movement were utilised: 20 cm, 25 cm, 30 cm, 35 cm, which were randomised in each of the four conditions. Within one group (15 children) and among groups (6 groups) a relatively equal distance was travelled for each condition to eliminate the possible effect of total distance travelled. The order of presentation of the conditions was randomised as was the order of the subjects for testing.

Procedures

The apparatus was placed on a table which was a comfortable height for the boys being tested. The boys sat in a chair facing the apparatus and this chair was always kept in the same position, located by chalk marks on the floor. The wall behind the apparatus was blank or was covered by a sheet of white paper.

The boys were tested in pairs. This was because testing for one boy took about 20-25 minutes and it was felt that this was too long a period of time to attend to the task in order to obtain maximum performance. Therefore, one boy would be tested on just one of the four conditions and then he would exchange places with the second boy who had been at another table either reading or drawing. The boy being tested could not see the activities of this second boy and there were no distractions.

Each boy was first allowed to inspect the apparatus and move the slide. It was explained to him that he was going to move the slide to a certain position, move it back, and after a certain length of time, try to remember his first movement position. He was then allowed to have a practice to a location not used for the actual testing. This was the first explanation and the first practice. An explanation was given as to the various types of intervals and interval activities that would be used. It was explained that sometimes there would be a long interval and sometimes a short interval, and during this time he would rest or perform a counting task. This took the form of counting backwards in threes, twos, or ones according to the age group of the child. In this way, an attempt was made to achieve optimum and equivalent difficulty for each of the subjects. In all cases an effort was made to occupy central processing space.

After this orientation each boy was tested on one of the four conditions. The actual instructions were as follows: " Take hold of the handle. Move the handle to the marker until the blue pointers are in line. Hold it there (3 seconds). Now move the handle back to the start. Turn your head away (to a fixed point on a wall) and think about where you moved to." This was the procedure in the rest condition. In the counting condition, the boy was asked to turn his head away and start counting backwards in ones, twos or threes from a designated number. After the interval, 10 or 30 seconds, rest or counting, the boy was told " Now move the handle to where you think it was before."

A score of ± cm was recorded. Four trials at the same condition were performed with a 15 seconds rest in between each trial. After each condition, the two boys changed places, the one who had just been tested moved to the reading and drawing and vice versa. This procedure continued until the four conditions were finished. The ease with which each boy understood the task was a feature throughout the testing situation with both normal and ESN boys.

RESULTS

Experimenters using a correct or target score have reported three error scores: absolute error, constant error (algebraic error) and variable error. Absolute error (AE) is the average difference between the subject's response and the correct response. Absolute error ignores the direction of the error. Constant error (CE), sometimes called algebraic error, is the average error when the signs of all the responses are taken into account and the average constant error also carries the sign. Variable error (VE) reflects the extent to which the subject tends to repeat his responses and is defined as the variability of the subject's performance about his own mean performance (i.e. his constant error). All three error scores are analysed in this study noting that AE may at times reflect VE or CE. Schutz and Roy (1973) and Newell (1976) provide discussions concerning the relative merits of the three error scores.

Absolute, variable and constant errors in all sections were analysed in a $3 \times 2 \times 2$ repeated measures analysis of variance design. All interactions were analysed using tests of simple main effects followed by Scheffé S test of pairwise comparisons, where necessary. The results based on CE added nothing to those based on AE and VE, therefore no further reference is made to this measure.

Educationally subnormal boys

The cell means of ESN and normal boys for the two error scores are shown in Tables 3 and 4.

The first analysis was designed to determine the developmental sequence of visual motor short term memory in ESN boys. There was no task by age interaction in any of the error analyses, therefore any developmental trends in ESNs were investigated by combining task scores across ages. Only VE produced a main effect for age.

Inspection of the pairwise comparisons revealed a significant difference between

TABLE 3

CELL MEANS FOR ESN BOYS

	Ages		
Absolute Error	6	9	12
Time 1 Rest	3·00	2·13	2·42
Time 1 I A	2·40	2·43	2·58
Time 2 Rest	3·22	3·15	2·37
Time 2 I A	3·72	3·87	3·49
Variable Error			
Time 1 Rest	1·92	1·68	1·52
Time 1 I A	2·01	1·66	1·79
Time 2 Rest	2·68	2·45	1·90
Time 2 I A	3·07	2·12	2·28

TABLE 4

CELL MEANS FOR NORMAL BOYS

	Ages		
Absolute Error	6	9	12
Time 1 Rest	3·08	1·18	1·30
Time 1 I A	2·95	2·75	2·67
Time 2 Rest	3·28	2·18	2·13
Time 2 I A	3·05	2·67	3·00
Variable Error			
Time 1 Rest	2·06	1·20	1·25
Time 1 I A	1·92	2·03	1·88
Time 2 Rest	2·36	1·59	1·54
Time 2 I A	2·03	2·60	2·10

6 and 12-year-olds (*F*, 2;187 = 3·65, P < ·05) with the 12-year-olds performing better than the 6-year-olds. This was the only developmental trend which occurred.

The second purpose was to describe the development of strategies of spontaneous rehearsal in ESN boys. In line with Broadbent's central processing notion, rehearsal was said to be taking place if there was a significant difference between the rest and interpolated task conditions. In the analysis of AE scores there was no main effect for task but there was an interaction between time and task. This is graphically represented in Figure 1.

At 10 seconds no difference between the tasks was apparent. However, there was a significant difference between tasks at 30 seconds thereby suggesting use of a rehearsal strategy. The analysis revealed that:

(*a*) At 30 seconds, ESN boys performed significantly better at rest than during interpolated activity (*F*, 1;84, = 8·55, P < ·01).

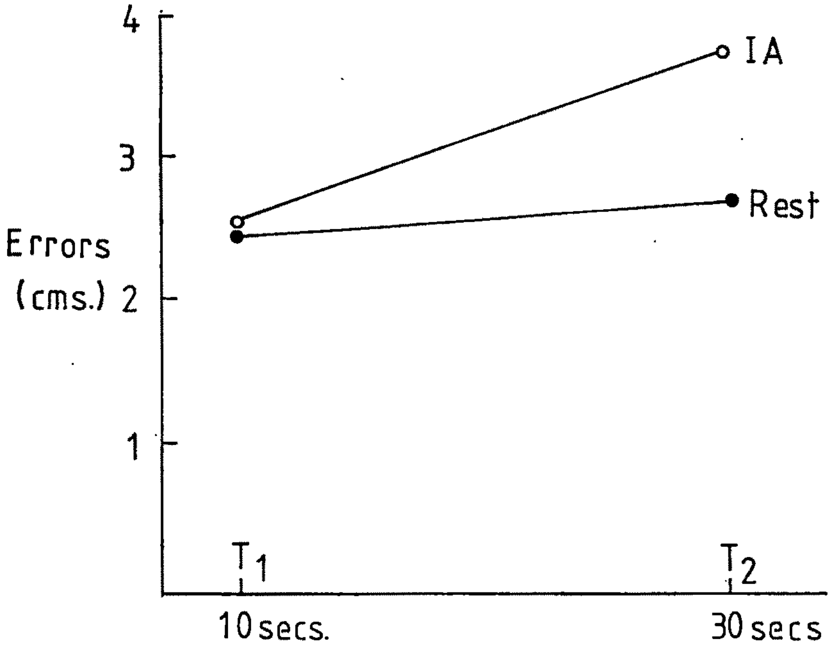
(*b*) During the interpolated activity condition, ESN boys performed significantly better at 10 seconds than at 30 seconds (*F*, 1;84, = 29·11, P < ·001).

Normals compared with ESN boys

The third purpose was to compare the scores of normal and ESN boys. Both absolute and variable error produced main effects for time, task and age. Time is dealt with as a main effect while task and age are investigated as part of interactions.

FIGURE 1

TIME BY TASK INTERACTION OF ABSOLUTE ERROR SCORES FOR ESN BOYS



The AE scores show a time-task-group interaction. The total interaction is graphically represented in Figure 2.

All possible tests of simple main effects and simple interaction effects were performed. The following differences were obtained:

(*a*) Combining ages and time intervals, normal boys are superior to ESN boys at rest (*F*, 1;168, = 6·63, P < ·05). There was no difference during the interpolated activity condition.

(*b*) Combining ages and tasks, normal boys are superior to ESN boys at 10 seconds (*F*, 1;168, = 4·08, P < ·05). There was no significant difference at 30 seconds.

(*c*) Normal boys at 10 seconds are better during a rest condition than interpolated activity condition (*F*, 1;168, = 21·8, P < ·001). At 10 seconds there were no differences between tasks for ESN boys.

(*d*) Both normal and ESN boys are better during rest than interpolated activity at 30 seconds. Normals (*F*, 1;168, = 9·02, P < ·01). ESNs (*F*, 1;168, = 9·77, P < ·01).

The VE scores showed a task-age-group interaction. This interaction is graphically shown in Figure 3.

The results of simple main effects and simple interaction effects showed that normal boys are superior to ESN boys during rest (*F*, 1;168, = 4·97, P < ·05).

A final comparison was made looking at both groups over the two time intervals of 10 and 30 seconds. There was a main effect for time in AE for normal boys (*F*, 1;42, = 11·06, P < ·01) and ESN boys (*F*, 1;42, = 22·39, P < ·001) as well as a main effect in VE, with normal boys (*F*, 1;42, = 5·00, P < ·05) and ESN boys (*F*, 1;42, = 25·02,

FIGURE 2

TIME BY TASK BY GROUP INTERACTION FOR ABSOLUTE ERROR SCORES

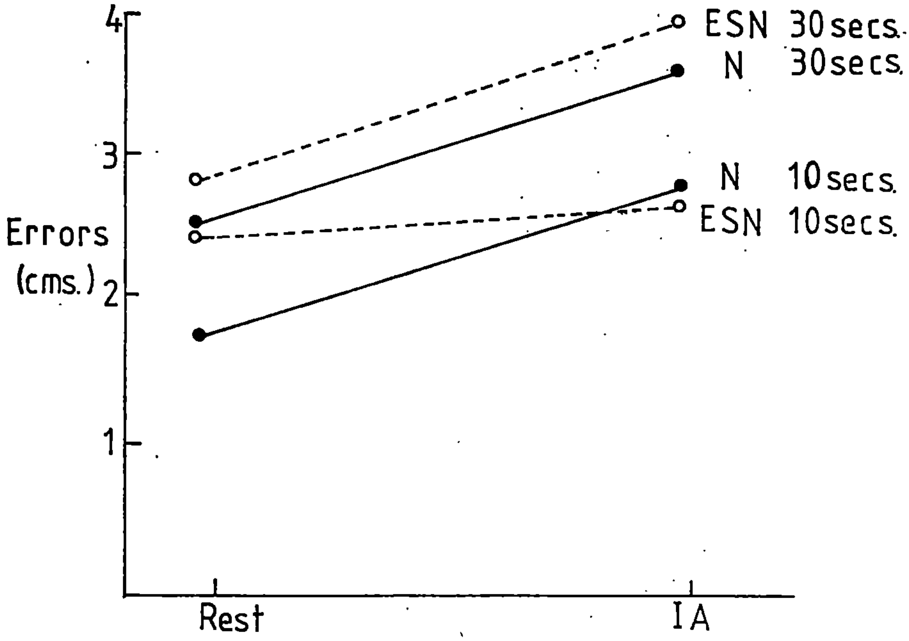
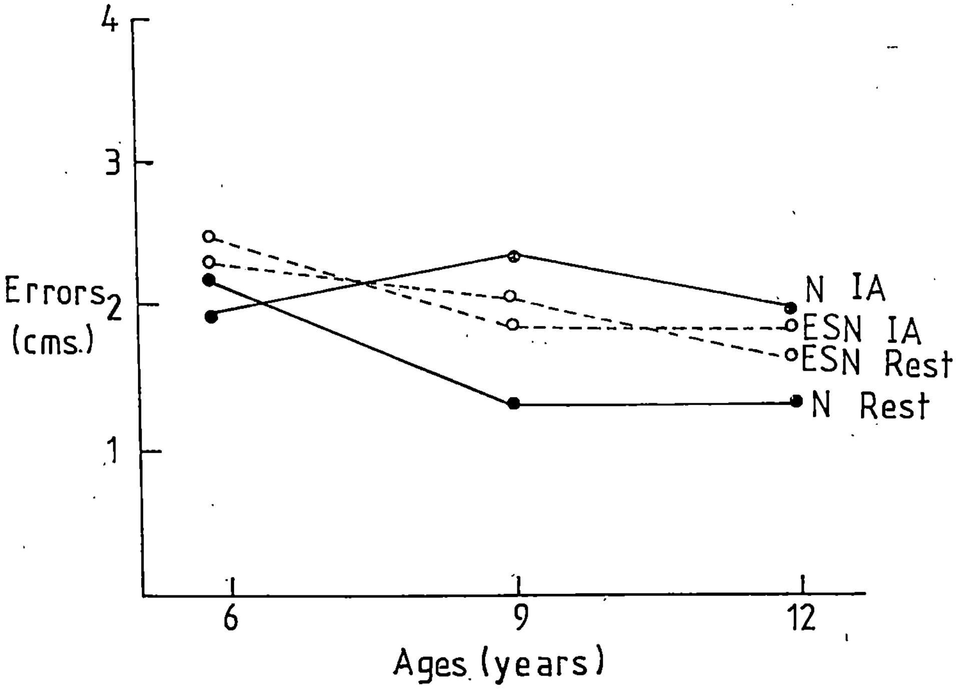


FIGURE 3

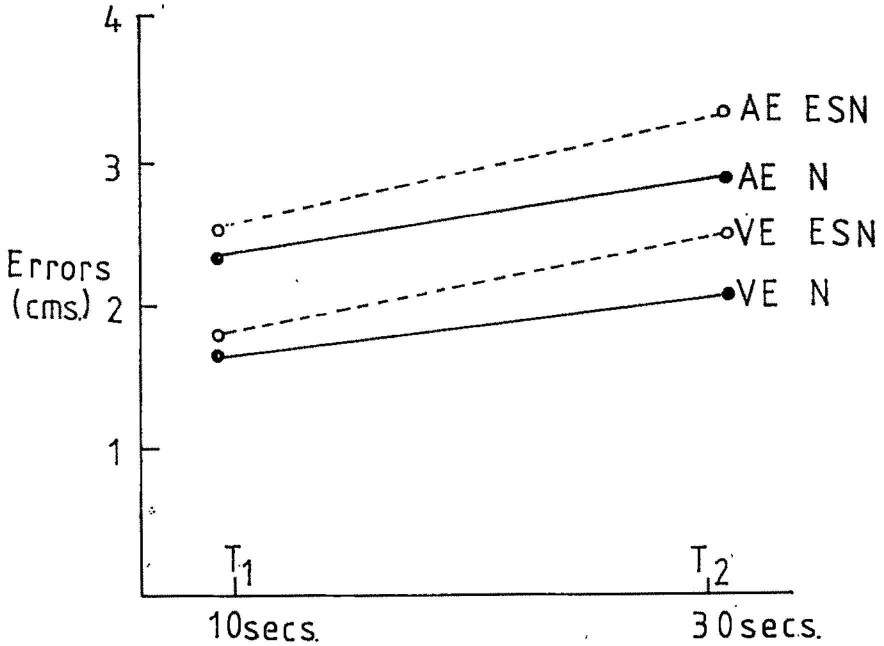
TASK BY AGE BY GROUP INTERACTION FOR VARIABLE ERROR SCORES



P<·001). In all cases, 10 seconds was better than the 30 second condition (see Figure 4).

FIGURE 4

MAIN EFFECT FOR TIME OF ABSOLUTE AND VARIABLE ERROR SCORES



DISCUSSION

A striking aspect of the results is the comparative absence of developmental trends. This absence is peculiar to the ESN boys as normal boys evidenced developmental improvement in all three error scores on the same visual motor STM task, and a second, purely motor STM task (Sugden, 1978). The only development shown in this study was that the 12-year-old group was more consistent than the 6-year-old group as measured by variable error. This lack of development is made more significant by the fact that the ESN boys were grouped according to mental age rather than chronological age. Flavell (1970) stated that if a mnemonic strategy is required for efficient performance on a task, developmental differences will be obtained. A further condition would seem to be that the performer possesses the capability of employing a mnemonic strategy. As would be predicted by Flavell, during interpolated activity, no development at all was evidenced, due either to the fact that mnemonic strategies were prevented or to the inability of the performers, or most probably, to both.

A difference between the rest and interpolated activity conditions indicated that during the rest condition a mnemonic strategy was being used. At 30 seconds, using absolute error scores, ESN boys performed better at rest than during interpolated activity. This was the only occasion when rehearsal was observed. By contrast, normal boys evidenced rehearsal at all occasions when central processing space was available (Sugden, 1978). This experiment confirms Brown's (1975) statement that a characteristic feature of the immature memoriser is an inadequacy in the spontaneous use of control processes, active mediational devices and strategic transformations of the input.

When comparing ESN boys to normal boys, all differences between the groups were evidenced during the rest condition. Normal boys, with both AE and VE scoring methods, performed significantly better than ESN boys during the rest condition. In effect normal boys were better in absolute terms and more consistent in their performance. This again suggests that when central processing space was available, normal boys used it effectively and differences between the rest and interpolated activity conditions were evidenced. For ESN boys, the condition made no difference to their performance, except in one instance. During the interpolated activity condition access to central processing space was not available and consequently there was no difference between the ESN and normal boys.

Belmont and Butterfield (1969) in reviewing studies of STM with mentally handicapped children, stated that more than one time delay was necessary to measure STM adequately. They broke STM down into three parts: acquisition, retention and retrieval. In their review of studies with two time delays, they concluded that there were no differences in retention between normal children and mentally handicapped children as the mentally handicapped did not lose any more information between the two time delays than did the normals. The present study used time delays of 10 and 30 seconds and the average AE and VE scores for normal and ESN boys are shown in Figure 4. The amount of retention loss between these two time delays was very similar for both groups whether absolute or variable error was the scoring method used.

The use of a visual motor task confirms and extends the results obtained on verbal and purely visual tasks. It is obviously not true that mentally handicapped individuals never rehearse, as there is one instance of rehearsal in the present study. However, it is clear that the mentally handicapped are much less likely to employ an efficient rehearsal strategy than are their chronological age, or as in this study, mental age normal counterparts.

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ON SHARED KNOWLEDGE: TEACHERS AND SEVERELY SUBNORMAL CHILDREN

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SUMMARY. The interaction between one teacher and two severely subnormal children, aged 6 and 8, in structured teaching sessions is described. The two children differed considerably in verbal comprehension of the crucial task attributes, colour, shape and size, and in the quality and quantity of their participation in the interaction. It was found that the teacher was sensitive to differences between the children and differed in certain aspects of the quality of her interaction, but not in quantity. However, these differences appear to be a function of relatively static models of the children and do not appear to be adaptive to the particular task involved.

INTRODUCTION

THE work reported here explores the means by which knowledge, initially solely in the possession of an adult, comes to be shared with a child. The aim of this paper is, by concentrating in detail on one very limited situation, to illuminate the nature of the approaches adopted by teachers of the severely subnormal (SSN) to instruct their children to assemble a simple constructional toy whose pieces are defined by the attributes of colour, shape and size.

These fundamental social processes until fairly recently seemed to have escaped the attention of most developmental psychologists. In the 1970s a new awakening of interest in the social basis of cognitive development was stimulated by research on the language addressed by mothers to their language-learning children (Snow and Ferguson, 1977), and by the field of mother-infant interaction from a cognitive perspective (Bruner, 1975; Schaffer, 1977).

The research reported in this paper turns some of the methods and assumptions of this research towards the study of the social basis of skill acquisition in severely subnormal children. Very little work indeed has been carried out with this population. Studies by Buium *et al.* (1974), Jones (1977), Marshall *et al.* (1973) and Mitchell (1976) are indicative of concern with mother-SSN child interaction, but there is a virtual absence of work on teacher-SSN child dyadic interaction: only two studies are available, both of which, for methodological reasons, are problematic (Smith *et al.*, 1973; Berry and Conn, 1976). The lack of interest in teachers, particularly with this group of children, is strange since they constitute a powerful part of the child's environment, often at a developmental level at which the normal child's chief interactor is his mother: the teacher is actively concerned with the SSN child's acquisition of language and other cognitive skills which in normal children develop in the social context of the home. Moreover, as the boundaries between home and school become less well defined and as SSN children are brought into full-time education from as young as 2, the interactional competence of teachers in this field is clearly a matter of some concern.

The process of sharing knowledge is cumulative: the teacher will build upon what is already shared with the child in order to transfer new skills. It is therefore vital that, in order to maximise the efficiency of instruction, the teacher should be highly sensitive to her child's abilities and adjust her teaching strategies accordingly. Wood *et al.* (1976) speak of the tutor's ' theory ' of the learner: an implicit model which directs the strategies adopted and which controls the extent to which the tutor provides ' scaffolding ' for the child—a convenient summary term used to describe the process by which a task is systematically simplified and broken into its constituent parts. It is this implicit model which is the focus of this paper.

EXPERIMENTAL DESIGN

In what follows one teacher is described teaching two children from her own class to assemble a constructional toy (see Figure 1). This teacher had taught for 22 years, 11 of which were spent teaching SSN children of all age groups. She had also taught delicate and normal children. The two children to be described had been in her class of eight children for 1 year 3 months. The task, adapted from Mitchell (1976), consists of eight pieces of wood which fit in a prescribed order onto a white base. The pieces vary in colour, shape and size and the attributes are non-overlapping: when all eight pieces are present all three attributes must be used to identify one piece unambiguously.

The teacher was asked to teach the task at whatever pace she felt appropriate and adopting whatever strategies she felt suited the children; she was under no pressure to complete the task, only to take the children as near as possible to success defined as one complete, correct and unaided assembly.

The main advantage of the task is the flexibility it offers to the teacher. She could in principle adopt a completely non-verbal approach by demonstrating and pointing; she could systematically reduce the number of pieces the child must choose from and thereby simplify the complexity of her commands, or she can leave the child to make complex decisions without any assistance.

Each child was taught for three five-minute sessions over three successive days in a quiet room. Sessions were videotaped but no-one apart from teacher and child was present in the room during teaching.

PRETESTS

The children were given a number of pretests before the teaching sessions and were selected for their differences in performance. A pretest related to the task was devised to measure the child's comprehension of the three task attributes. It is a picture-referent test consisting of 44 items in groups which measure the child's comprehension of individual attributes, and combinations of two and three attributes. Each item consists of an array of shapes mounted on a white card, 9″ × 15″. The child is required to point to one shape in response to commands of the form: " Show me the (red one) ". One-dimensional items consist of arrays of two cut-outs varying in only one attribute; there are three groups of eight items, each group testing one attribute. Pass rate, calculated on the basis of the binomial distribution, is 7 correct out of 8. This score has only a 5 per cent probability of occurring by chance. Similarly, two-dimensional items comprise arrays of four items varying only in two dimensions. Three sets of four items test the three two-dimensional combinations of colour-size, size-shape and shape-colour, and pass rate, again at the 5 per cent level, is 3 correct out of 4. The final set consists of 8 items testing the three-dimensional combination of colour, shape and size; pass rate here is 4 correct out of 8. Position of the target item is randomised within each set of items, and the non-criterial dimensions of one- and two-dimensional items are systematically varied. The test is administered in two parallel sessions of 22 items over two days, and order of presentation within each session is randomised. Inter-session reliability, based on 27 SSN subjects aged 5:0-9:7, is 0·81. Children were also given the English Picture Vocabulary Test (Preschool Version) (Brimer and Dunn, 1962) and a task assembly pretest in which they were provided with an identical assembled task and asked to " make theirs like that one ".

PRETEST RESULTS

The results for the two children to be discussed are presented in Table 1. James, a Down's syndrome boy, was aged 8:3; Anne was aged 6:0. Both children were living

FIGURE 1

THE TASK: CROSS-SECTION

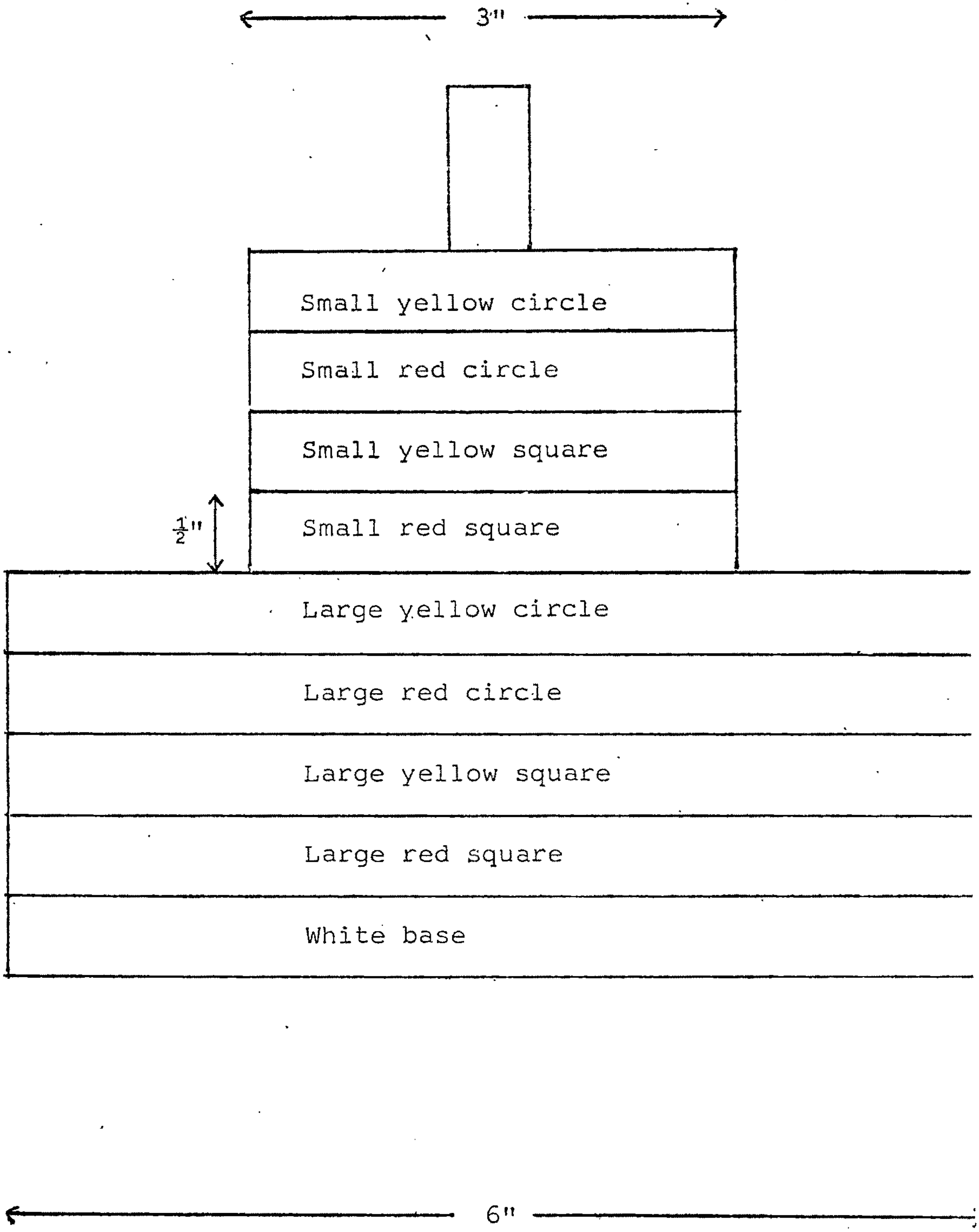

TABLE 1

PRETEST RESULTS

	EPVT–VA	Colour	Shape	Size	Colour + Shape	Size + Shape	Colour + Size
Anne	3 : 9	Fail	Fail	Pass	Fail	Fail	Fail
James	6 : 7	Pass	Pass	Pass	Pass	Pass	Pass

	Colour + Shape + Size
Anne	Fail
James	Pass

at home with both parents and had no known visual, auditory or motor handicaps in addition to their general retardation. The children were quite different in their ability to understand the task attributes and in more general verbal comprehension, as demonstrated by their vocabulary ages; on the other hand they both assembled the model in the pretest in a random manner.

Transcription and coding

The videotaped data were transcribed on to four parallel streams which record the verbal and non-verbal behaviour of teacher and child. All verbal behaviour and all non-verbal gestures which were involved with the task were recorded. (Direction of gaze is not recorded.) The unit of analysis was the act of communication, roughly equivalent to Barker and Wright's (1955) notion of phase, described as:

> "... the smallest behaviour segment in the action hierarchy ... a minimal unit of action in the sense that descriptive subdivision of it would break it into actones."

Actones comprise muscular events which do not necessarily imply goal-directed behaviour. Thus the unit is molecular: verbal acts were generally equivalent to per-breath utterances, non-verbal acts generally constituted one complete movement with reference to one part of the task.

Acts were subsequently coded in three sets of parameters: Primary Act Type or Function; Form; Content. The constrained nature of the goal bound situation limits the number of alternative act types: for example, Searle's (1976) declarations and commissives are virtually non-existent. Act types are defined by their function in the interaction, and not by their syntactic modality. Thus, for example, not all commands are in the imperative; indeed the syntactic options selected by the teacher in the expression of demands are of considerable interest. Ten act types have been identified which account for nearly all of the acts produced, whether verbal or non-verbal.

Of these, four types account for, on the average, 80 per cent of the teacher's behaviour and two of these account for, on the average, 80 per cent of the child's behaviour:

1. *Statement.* An act which does not expect a response and which does not directly depend upon any previous act. The minor misuse of Statement to cover non-verbal behaviour should be noted here.

2. *Feedback.* An act which evaluates, acknowledges or provides information about the other person's previous act or acts.

3. *Command.* An act which expects the hearer to do something as a direct result of the Command. The nature of the response is known to the actor in advance.

4. *Response.* An act contingent upon a previous command or statement by the other actor, which would be unlikely to occur in the absence of the act on which it is dependent.

The categorisation of content diverges for each of the four act types described. Because of their central position in instruction, the analysis here concentrates on commands. Initially, they were categorised according to the context in which they occur, and each of these groups was further subdivided.

A. Assembly. Here the command is concerned with establishing joint reference between teacher and child; with getting the child to identify one element of the task in order eventually to put it on the base. The possibilities for strategy variation are greatest here, and fall into five groups.

I Reference to an adjacent element
e.g. " What comes after the red square? "

II Direct reference to the required element
e.g. " Pick up the big red square "

III Request for identification
e.g. " Which colour comes next? "

IV Reference to previous demonstration
e.g. " Now you do it the way I did it "

V Recursive/General
e.g. " Put the pieces on the way they should be "

B. Identification. Commands of this type are concerned with describing an element of the task after joint reference has been established. Some commands have a surface similarity to assembly commands: for example, " What colour is this? " (Holds up large red square) and " Which colour next? ", but these differ crucially in that the second involves finding an element and the first describing it after its isolation as temporary referent. Five subtypes of command in this context were isolated:

I Nonspecific
e.g. " Tell me about this one "

II Label required
e.g. " What colour is this? "

III Selection from stated labels
e.g. " Is it red or yellow? "

IV Verification
e.g. " Is this red? "

V Recursive
e.g. " Tell me the colours "

C. Disassembly. The central feature of this context is that the referent is immediately identifiable in the task, namely the piece on top of the pile. It should be noted that ' context ' is used here in an interactive rather than a temporal sense. When a child takes off a piece, a teacher may ask: " What colour is it? " This would be classified as an Identification command.

D. Orientation. This context covers all commands concerned with gaining the child's attention, general control and specific focusing on parts of the task.

Commands were also coded using three further categories:

1. *Alternatives available.* One method of varying the complexity of assembly commands is to vary the number of alternative referents the child must choose from. Irrespective of the semantic complexity of the actual command, laying out all eight pieces imposes a much heavier information load on the child than if the teacher removes all but two. Thus, the number of alternatives available when the command is issued is recorded here.

2. *Focus.* In this category, the use of attribute superordinate labels was recorded. Thus, " What colour is this? " focuses the child on one attribute, as does " What shape comes after the square? "

3. *Description.* Commands may vary in their use of the task attributes to refer to elements of the task: " Pick up the big red square " is considerably more difficult than " Pick up the square " (although it should be noted that this is only true if the number of alternatives available is varied in parallel). Which and how many attributes are used was recorded here.

4. *Adjacent Description.* This parallels the previous category but records which attributes were used to refer to an element which is not the target, but which lies next to it on the base; for example: " What comes after the *red*? "

RESULTS

The differences between the two children in ability on the pretest were reflected by differences in the teaching sessions. Table 2 shows the distribution of acts produced by the children. Anne, the less able child on the pretests, was limited to task-relevant statements and responses whereas James engaged in off-task behaviour and also made some demands of his teacher. Moreover, Anne made many more responses than did James, which suggests she had a rather more passive, reactive role in the interaction. This is confirmed by the observation that most of James' off-task behaviour was initiated by himself—he was particularly interested and questioning about the camera.

TABLE 2

DISTRIBUTION OF CHILD COMMUNICATION ACTS

		Statement	Response	Command + Question	Off-task	Unclear or Unclassified	Total
Anne	N	55	90	—	—	—	145
	%	37·9	62·1				
James	N	76	110	9	15	22	232
	%	32·8	47·4	3·9	6·5	9·4	

$\chi^2=33{\cdot}08$, $P<0{\cdot}001$ (combining command + question, offtask and unclear or unclassified)

TABLE 3

DISTRIBUTION OF TEACHER AND CHILD ACTS

		Teacher	Child	Total
Anne	N	303	145	448
	%	67·6	32·4	
James	N	352	232	584
	%	60·3	39·7	

$\chi^2=5{\cdot}93$, $P<0{\cdot}02$

TABLE 4

DISTRIBUTION OF TEACHER ACT TYPES

Addressed to:		Statement	Feedback	Command	Other	Offtask	Unclassified or Unclear	Total
Anne	N	52	60	132	43	2	14	303
	%	17·2	19·8	43·6	14·2	0·7	4·6	
James	N	54	89	139	43	19	8	352
	%	15·3	25·3	39·5	12·2	5·4	2·3	

$\chi^2=17{\cdot}60$, $P<0{\cdot}01$. Excluding offtask: $\chi^2=5{\cdot}94$, NS

A further point which emphasises the difference between the children is that in 15 minutes Anne produced only two units with any verbal content, each of which was only one word, whereas James was highly verbal: his utterances ranged from many responses which involve labelling, to " I haven't got four hands ! " as a protest against being asked to take off the pieces.

It follows that one might expect James to have taken up a larger part of the interaction than Anne and this was in fact the case (see Table 3), although the difference was not as large as one might expect.

Table 4 shows the distribution of teacher acts addressed to the two children. There is a significant difference between the two distributions, but this is completely due to the Offtask category. Since the teacher's acts here were part of child initiated sequences, one can argue that they do not form part of her chosen strategy. Omitting this category yields a non-significant result ($\chi^2=5{\cdot}49$, df$=4$, NS). Strategy differences, therefore, were not evident in the amount of commands, feedback and statements made by the teacher.

TABLE 5

USE OF ATTRIBUTES IN COMMANDS BY TEACHER: (NUMBER OF REFERENCES IN FOCUS, DESCRIPTION AND ADJACENT DESCRIPTION)

Addressed to:		Size	Colour	Shape	Total
Anne	N	12	64	39	115
	%	10·4	55·6	33·9	
James	N	11	34	30	75
	%	14·7	45·3	40·0	

$\chi^2=2{\cdot}08$, NS

TABLE 6

DISTRIBUTION OF TEACHER COMMAND CONTEXTS

Addressed to:		Assembly	Identification	Disassembly	Orientation	Other	Total
Anne	N	39	25	16	39	13	132
	%	29·5	18·9	12·1	29·5	9·8	
James	N	49	33	14	28	15	139
	%	35·2	23·7	10·1	20·1	10·8	

$\chi^2=4{\cdot}71$, NS

TABLE 7

DISTRIBUTION OF ASSEMBLY COMMAND TYPES

Addressed to:		I	II	III	IV	V	Total
Anne	N	2	26	5	3	3	39
	%	5·1	66·7	12·8	7·7	7·7	
James	N	10	18	20	1	—	49
	%	20·4	36·7	40·8	2·0		

$\chi^2 = 17{\cdot}83$, $P < 0{\cdot}001$ (combining Types IV and V)

TABLE 8

DISTRIBUTION OF IDENTIFICATION COMMAND TYPES

Addressed to:		I + V	II	III + IV	Total
Anne	N	1	14	10	25
	%	4·0	56·0	40·0	
James	N	3	29	1	33
	%	9·1	87·9	3·0	

$\chi^2 = 12{\cdot}86$, $P < 0{\cdot}01$.

Table 5 shows the use of the three task attributes in commands. Although there was a slight preference to use colour with greater frequency with Anne, this difference must be attributed to chance. Table 6 shows the relative use by the teacher of command contexts, and again the difference between the acts addressed to the two children was not significant.

Differences in strategy were found in the types of command used within the assembly and identification contexts. Table 7 presents the frequency of command types in the assembly context. Here, James received many more Type III commands as compared to a bias of Type II commands addressed to Anne. Type III commands which require the child to identify the element but give no direct help at all (e.g. " Which shape is next? ") are clearly more difficult than Type II which offer precise information to help find the required element (e.g. " Pick up the square "). Furthermore, the teacher used more Type I commands, which refer to an adjacent element with James, a difference which confirms the greater complexity of assembly commands addressed to him. In Table 8, differences in the same direction are also evident in the identification context. James was required to label elements more frequently (Type II) whereas Anne received many more commands requiring Yes/No answers (Types III and IV).

The general pattern of more complex commands addressed to James is given further support by comparing the number of attributes used in commands which provide direct information about the elements of the task. Although Anne received more of this type, they were semantically less complex, with a mean of 1·50 attributes ($N = 38$) compared to 2·22 ($N = 23$) for James. This difference is statistically significant: $t = 4{\cdot}15$, $P < 0{\cdot}001$. A more general measure of linguistic complexity of commands, mean length of act, also revealed a significant difference in the same direction, although only in assembly and disassembly contexts. (Assembly: Means, Anne: 4·39, James: 6·43, $t = 4{\cdot}13$, $P < 0{\cdot}001$; Disassembly: Means, Anne: 2·80, James: 5·54, $t = 2{\cdot}33$, $P < 0{\cdot}05$.)

DISCUSSION

These results support the hypothesis that the teacher has implicit models of the two children's abilities which lead to significant differences in her use of interaction strategies. To the more able child, James, she provided more complex commands in the two central contexts of this task: when the child is required to identify elements and assemble the model. The differences in strategy matched clear differences between the children in abilities and behavioural characteristics. Adjustments were made which parallel the sort of adjustments mothers make to their children learning to talk.

However, it does not necessarily follow that such adjustments were adaptive to the children in this particular situation. In order to demonstrate this, it would need to be shown that the adjustments made were in part the result of the interaction itself. Wood and Middleton (1975) found that successful instruction with normal preschool children was related to adjustments in level of complexity of 'intervention' based on the child's previous responses within the interaction session. Although the present nominal coding system does not permit the analysis they used, a comparable analysis is possible by examining the occasions on which the child made an incorrect response to a command. If systematic adjustments are made on the basis of the child's response, then one would expect fewer of the particular command type involved to occur *after* the incorrect response than occurred before it. Of course, it is necessary to correct these figures by expressing them as percentages of the total numbers of commands before and after the incorrect response. The difference between these two percentages indicates the degree of change (in either direction), and averaging the differences yields a global index of the degree of adjustment produced as a result of the interaction. In fact, there is no evidence of this type of adjustment at all. Looking at assembly commands, the mean per cent adjustment is in both cases marginally in the direction of *increasing* the frequency of the failed command type, by 2·35 per cent for Anne and 16·15 per cent for James.

This suggests that the adjustment in strategy is the result of an implicit model the teacher brings to the interaction, resulting from diffuse past experience, but not readily modified.

It is often held that a good teacher is a sensitive teacher, whose sensitivity to her children should result in differences in the way she interacts with them. The significance of this statement is highlighted when we consider SSN children, whose inter-individual differences are often far greater than normal children. The work reported here suggests that a teacher may be sensitive to differences and demonstrate this in her interaction, but this does not necessarily make the interaction effective. Rather, the essential sensitivity is to *the interaction between the child and the task at hand.*

One child in two different situations may manifest different levels of competence, and it is to this level of competence that the adult responds. Clearly there will be certain ' confidence limits ' beyond which the adult will not expect the child to pass in any situation, and thus some global level of adjustment may exist as a baseline for the interaction. Brown (1977) discusses speech adjustment as a global register controlled by a fairly simple model of a child as " + inspiring affection, tenderness and intimacy " and " − verbal production − verbal comprehension and − cognitive competence ". Yet, as Brown himself points out, the degree of adjustment known to occur demonstrates a level of ' fine-tuning ' along a continuum far more sophisticated in its causation. Snow (1972) showed that in the absence of the child, mothers did reduce MLU (Mean Length of Utterance) as compared to non-mothers, which suggests some global notion of simplification, but the effect is far more dramatic when the child is present as an interactor.

It is also well established that global task differences cause differences in adult strategy. Characteristically, the presence of specific task objectives as opposed to a free-play context leads to an increased use of imperatives. Buium *et al.* (1974) found that this occurred with Down's Syndrome children, accompanied by changes in the frequency of single word and grammatically incomplete sentences. Fraser and Roberts (1975) compared story-telling and a constructional task with children aged from 18 months to 6 years and found significant task differences in measures of grammatical complexity, redundancy, productivity and in MLU. However, such results are unlikely to account fully for all adjustments made. Mothers studied demonstrate both child *and* task adjustments; furthermore, child-task interaction effects have been established. Fraser and Roberts (1975) found that with 18-month-old children there was very little difference in mother's grammatical complexity between the two tasks, but at 30 months the difference was quite marked. The most straightforward explanation is that younger children failed to respond differentially to tasks to the extent necessary to elicit differences in the mothers' speech.

To return to the present data, clearly the teacher was aware of the differences between her two children, but this awareness failed to fit into the current task. Indeed the global differences between the two children appeared to mask the crucial differences in task performance. Thus her models of the children and of the task failed to interact to produce the necessary moment-by-moment adjustments. It would be incorrect to say that the teacher's model of the child was out of step with the child's actual ability, and obviously wrong to say the teacher was unaware of the nature of the task. A more plausible hypothesis on which to base further work is that the ' baseline ' model of the child may be very rigid and may fail to interact with any given novel situation. Thus changes in the model of child may occur only as a result of a lengthy accumulation of new evidence drawn from many different situations.

NOTE: Subjects' names have been changed to preserve confidentiality.

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RESEARCH NOTE

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AN EVALUATION OF THE McCARTHY SCALES OF CHILDREN'S ABILITIES

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SUMMARY. The McCarthy scales which were designed to assess general intellectual abilities in the 2½ to 8½ age-range are described and criticised on the basis of substantial experience in their use as a research instrument. It is concluded that the test is particularly useful for the assessment of the pre-school child.

DESCRIPTION OF THE SCALES

The McCarthy Scales of Children's Abilities (MSCA, McCarthy, 1970) were designed to assess the general intellectual abilities of children in the 2½ to 8½ years age-range. As such, they constitute a single instrument which nevertheless taps a wide variety of cognitive and motor abilities and which is suitable for use both with normal children and those with learning disabilities. Norms are provided for six scales: Verbal, Perceptual-Performance, Quantitative, General Cognitive, Memory and Motor, each of these being based on the child's performance on a number of individual tests. The composition of the six tests is shown in Table 1. Normative scores for the six scales are provided at three-monthly intervals across the age-range and are based on a nationwide sample of 1032 American children. The comments that follow are based on the author's experience with the anglicised version of these scales as recommended by the NFER. They are based primarily on research work with children undergoing treatment for leukaemia (Eiser and Lansdown, 1977) which has been carried out over the last three years.

Special features of the test

The test is well presented and the materials attractive. Order of presentation involves a good balance of verbal and non-verbal items that is conducive to maintaining interest in very young children. Conventional tests of number and vocabulary are included, but, in addition, McCarthy has introduced several more original items. These include, for example, a test of *conceptual grouping* in which the child must classify a set of blocks according to various combinations of shape, size and colour, and a test of *tapping sequence*, in which the child must remember, and then reproduce, a series of sounds made by the examiner on a xylophone. The motor scale is particularly good, including tests of gross leg and arm co-ordination (e.g. balancing on one foot, skipping, catching and throwing a beanbag, bouncing a ball) and the more fine skills necessary to draw and reproduce abstract designs. The memory scale involves short-term recall of numerical, verbal and non-verbal material.

SPECIFIC CRITICISMS

(*a*) Some of the individual tests do not adequately discriminate right across the age-range studied. This criticism applies both to the *number questions* and *verbal knowledge* tests. For the former, the child is first asked ' How many eyes, heads, noses have you? ' The questions then go on to test the child's knowledge of elementary addition and subtraction rules. Even the youngest children are invariably correct for the first three questions, while it may be several years later before they begin to score on later items. The first three questions do not require real numerical skills, and it is therefore somewhat misleading to attempt to assess younger children on this test. To some extent, the *counting and sorting* task fulfils this need, but the value of including a test which does not discriminate across the age-range seems limited.

The same criticisms can be made of the *verbal knowledge* test. This is divided into two parts; the first requiring the child to point to five of six pictures of common objects named by the examiner, and name four objects from pictures. The second part is the more conventional test of vocabulary, where the child must define ten words. The words are 'graded in difficulty, and range from concrete, familiar words to abstract concepts' (p.9). In fact they appear a somewhat haphazard selection, possibly chosen without regard to frequency of usage. Certainly Thorndike–Lorge frequencies are not quoted.

TABLE 1

Individual Tests and their Relation to the Six Scales. Adapted from Manual of the McCarthy Scales of Children's Abilities, McCarthy, 1970

TEST	*Verbal*	*Perceptual-Performance*	*Quantitative*	*General Cognitive*	*Memory*	*Motor*
Block Building		*		*		
Puzzle Solving		*		*		
Pictorial Memory	*			*	*	
Word Knowledge	*			*		
Number Questions			*	*		
Tapping Sequence		*		*	*	
Verbal Memory	*			*	*	
Right-left Orientation		*		*		*
Leg Co-ordination						*
Arm Co-ordination						*
Imitative Action						*
Draw-a-Design		*		*		*
Draw-a-Child		*		*		*
Numerical Memory			*	*	*	
Verbal Fluency	*			*		
Counting and Sorting			*	*		
Opposite Analogies	*			*		
Conceptual Grouping		*		*		

Again, almost all of the youngest children assessed have been able to gain full score on the first half of the test, while it is often not until nearer 5 years of age that they begin to be able to define words. A test of intermediate verbal knowledge is called for, requiring the child to use some language skills rather than just point to items, but not the degree of skill involved in defining words. Perhaps asking the child to name objects serving specific functions would be appropriate (e.g. ' What do we call the thing we eat soup with? '). I feel that as it stands, this test does not comprehensively test the verbal skills of many children in the 3-5 year range.

(*b*) The objection that the above scales do not distinguish between children in the 3-5 year age range is particularly valid in that the scales as a whole are not suitable for use with the brighter 7-8 year-old. This problem was recognised by McCarthy (p. 28) but I have found that several items (e.g. *block building*, *counting and sorting*, and to some extent *conceptual grouping*) are too easy for many children over 6 years of age.

(*c*) A problem in identifying specific learning difficulties lies in the extent to which individual items contribute to the scores on several of the six scales. There is considerable overlap in content between the Verbal-Memory, Perceptual/Performance-Motor and Quantitative-Memory Scales. Where a child scores poorly on any two scales, it is not always easy to distinguish very precisely in which area of cognitive functioning his greater difficulty is. The MSCA can only be considered as a very preliminary indicator of specific deficits.

(*d*) Although norms are provided for the six overall scales, no norms are given for the individual tests, but only a brief table of mean scores over quite wide age-ranges. While aware of the poor reliability usually associated with such individual items, it would be helpful to have a more extensive table of normative scores for the individual items, as appears in the WPPSI for example.

(*e*) Finally, I feel the MSCA would have been improved by the inclusion of two types of test. The first involves questions of a general and personal knowledge nature, much along the lines used by Winett *et al.* (1975). These questions are not only good for putting the child at ease but also enable the examiner to assess some aspects of long-term retention and to infer something of the child's background. The second omission is a test similar to *Animal House* in the WPPSI. There is a need for a complex test such as this in which the child's ability to work alone for a short time can be observed.

Despite these criticisms it must be remembered that the MSCA are a comprehensive measure of the young child's ability, particularly given the lack of other suitable instruments available for the 2½-5 years age range. The test should be carefully considered by all those involved in the assessment of the pre-school child.

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CONFERENCE ABSTRACTS

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THE STRUCTURE AND DYNAMICS OF TEACHERS' PERCEPTIONS OF PUPILS IN THE RECEPTION CLASS

While recent work in the field of ' teacher effects ' has suggested that teachers' impressions, perceptions, and opinions of children have important influences on their school careers, little research has been directed towards the question of which characteristics of their pupils teachers actually attend to and consider important.

Studies by Nash (1973) and Taylor (1976) have suggested ways of approaching this problem, but have produced conflicting findings: the former stressing that the social aspects of children's behaviour are considered most important, the latter that academic criteria predominate.

In this study, repertory grid tests and informal interviews were conducted on four separate occasions with a group of 18 reception class teachers, in order to investigate the structure and dynamics of their perceptions of their pupils. Particular attention was paid to two points: whether the types of characteristics deemed important changed over the year (e.g., whether judgments of ' social adjustment ' become less frequent later in the year); and whether perceptions of individual children remained stable or showed significant changes over time.

Results suggested that there are differences among reception teachers as to the ways in which they perceive their pupils—some teachers stressing social adjustment, and others attending mainly to ability and achievement from an early stage. In general, academic criteria were more commonly found later in the year.

In addition, it was found that first impressions of pupils were usually lasting ones. However, by interviewing teachers about those pupils whose images did alter, an attempt was made to determine what ' key events ' precipitated changes in the teachers' views of children.

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A CROSS-CULTURAL STUDY OF WITKIN'S PSYCHOLOGICAL DIFFERENTIATION IN CHILDREN IN SCHOOLS IN ENGLAND AND JAMAICA

Hypotheses derived from studies stemming from the work of Herman Witkin on psychological differentiation have been tested in a comparison of cognitive style in English 10-year-olds in rural and urban schools and children of similar age of Jamaican parents, in the British urban schools studied, and Jamaican children in Jamaica attending rural and urban schools. In the rural Jamaican children, sex was a major factor mediating style of socialisation (measured by the child's description of the parental exercise of authority) in so far as it affects perceptual or cognitive style. The results for the contrasted groups of children in the English schools point to significant class differences in psychological differentiation of black and white children from working-class backgrounds. Significant differences in cognitive style between children of Jamaican parents in England and in Jamaica point to the acculturating affects of migration. The distinctive pattern of parental authoritarianism and psychological differentiation in boys in rural Jamaica, which is contrary to the original hypothesis, is discussed in the light of anthropological accounts of the Jamaican family. A replication of this work in rural and urban areas of Japan is briefly described, and results may be to hand.

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VISUAL AND OCULAR CONTROL ANOMALIES IN RELATION TO READING DIFFICULTY

Based on the inference found by Bedwell from examining individual pupils with reading difficulty, and from his previous research projects in school, a group of 13-year-old successful readers were compared with a group of the same age who were retarded in reading. Each group was assessed for reading ability by Grant by being asked to read aloud a passage in the Neale Analysis which was well within the capacity of every member of the group. Criteria for selection and experimental controls are discussed.

The pupils were placed in random order, and the visual acuity for distance vision recorded on a standard Snellen visual acuity chart. Visual acuity for distance and near vision, binocular co-ordination for static viewing at distance and near fixation, and stereoscopic vision, were examined on a standard vision screener. The range of fusion was assessed using polarised vectographs. All pupils were asked if during reading letters or words appeared double.

Various aspects of dynamic eye behaviour and binocular control were then investigated objectively while the pupils were actually reading. At the same time head movements employed in an attempt to compensate for inadequate visual scanning were observed, and also indications of ocular stress.

The data were analysed statistically by McKeown. On the tests of static viewing only a tendency for vertical deviation and poor stereopsis appeared significant in relation to reading difficulty. On the tests of dynamic vision all aspects examined appeared very significant. This research supports the notion that problems of dynamic viewing and ocular control while reading are important.

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ENHANCING SELF-CONCEPT IN THE CLASSROOM

Every individual exists in a continually changing world of experience, of which he is the centre. His only purpose is to promote his own survival and enhancement. From this centre he perceives his environment and assimilates its influences, and develops a concept about his own capabilities, appearance, feelings, attitudes, and knowledge.

If we accept that we each have thousands of beliefs about ourselves, which fit together into a fluid but meaningful system, each belief complementing the others to form the whole, and that these beliefs are learned, not inherited, we can see how difficult it must be to change the whole system. Any new information must fit into the whole or it may be rejected by the organism, at least initially.

Looking at the implications of this for education, by the time a child reaches school, his self-concept is well formed, and largely determines his behaviour; learning is one function of behaviour. Research done at Wayne State University, with infants, in 1962, showed that a measured self-concept was a more accurate predictor of reading success than an IQ test.

Despite the difficulties in changing self-concept, it has been proven in the Ford-Esalen project and other similar projects that confluent education (literally the 'flowing together' of cognitive and affective learning) can have a direct impact on self-concept, and can be incorporated into the ordinary curriculum without loss of time or money.

The goals of confluent education are roughly the same as the goals for Client-Centred Therapy set out by Carl Rogers:

The person comes to see himself differently;

He accepts himself and his feelings more fully;
He becomes more flexible, less rigid in his perceptions;
He becomes more confident and self-directing;
He adopts more realistic goals for himself and behaves more maturely;
He becomes more open to the evidence of what is going on inside and outside of himself.

These goals can be approached in school by using techniques which:

1. Make the child responsible for his own learning and behaviour;
2. Help the child to clarify his own values;
3. Give purposeful training in communication (talking and listening);
4. Promote realistic self-assessment;
5. Promote acceptance of self and others;
6. Validate the child's positive self-concepts (I'm O.K., you're O.K.).

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PARENTS' EXPECTATIONS OF THEIR CHILDREN IN THEIR FIRST TERM AT SCHOOL

The evidence both from research and the experience of teachers has indicated the educational significance of the correlation between parental attitudes and children's school performance. The present research was an attempt to look more closely at the dynamics of this relationship. The focus was on the parents' own perspective and, in particular, on their expectations of their children who were about to start school and whether or not these expectations were confirmed after the children had completed their first term's schooling.

Two loosely structured interviews were held with the parents of a sample of 50 children who were just beginning school. One interview was held in the term before the children started school and the other interview was held after the children had completed their first term. Interviews were also held at similar intervals with the parents of a small control group of children who were just coming up to school entry, so providing some indication of possible changes in parental expectations that might take place without the intervention of school.

Preliminary findings suggest that the majority of parents in this sample were able to predict their children's performance in school fairly well with a tendency towards underestimation. Some of the reasons for accurate predictions are explored and instances of inaccurate prediction are examined.

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A FOLLOW-UP STUDY OF CULTURALLY DISADVANTAGED CHILDREN

A follow-up study was carried out at the late primary school and early secondary school stages of a group of 50 children from urban culturally disadvantaged homes and a matched control group of 47 children from more advantaged, ' working class ' homes. Both groups had originally been studied during their infant school careers as part of the Schools Council's Research and Development Project in Compensatory Education (Chazan *et al.*, 1976, 1977). The aim of the follow-up study was to compare the two groups in terms of their educational attainments, social and emotional adjustment and attitude to school, and on selected personality variables.

The disadvantaged children scored significantly lower than their controls on tests of oral and written language, reading, spelling and mathematics, and were judged by their teachers to be less well adjusted both to their junior and secondary schools. Differences between the two groups in measures of self-esteem, academic motivation, introversion and neuroticism were all non-significant, although generally favouring the control group. Overall, the differences between the two groups were most pronounced in the area of reading skills and least marked in the area of personality and motivation. Further, it was found that the disadvantaged children had made significantly lower gains in reading test score than their controls between the ages of 7+ and 11+ years, and that a substantial proportion of them were seriously backward in reading at the latter age.

These results are attributed mainly to differences between the children's home backgrounds and their educational implications are briefly discussed.

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PROFESSIONAL COMPETENCE AND CRAFT PERFORMANCE IN THE RECEPTION CLASS

Twelve reception class teachers were asked to identify sections of the ' Mathematics for Schools ' scheme which caused their pupils difficulties. The teachers also gave their opinions on the cause of these difficulties, their accounts of how they might deal with the problem and how they actually did deal with the problem. The data suggest that whilst teachers exhibit many of the skills of experimental psychologists in describing possible task specific problems these inferences are abandoned when choosing tasks for children or when amending the tasks. The differences between the teachers' professional insights and their professional actions are discussed with reference to the study of teachers' professional skills, teacher expectation effects, and the institutional constraints on teachers' actions.

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THE SCHOOL EXPERIENCE

The school experience is one which, though it may seem to begin well, ends badly for large numbers of children. The demands of society for intellectual competence—the traditional ' core ' demands of Western education—remain as insistent as ever, whether we like it or not; and very many children fail to meet them, with consequences that are personally damaging and socially dangerous. For educational psychologists the question is whether their discipline can now propose the radical remedies which are urgently needed.

The heart of the problem is to understand the real nature of the gap between the very considerable linguistic and cognitive achievements of pre-school children and the intellectual skills which they are expected to acquire. Recent research throws new light on this disparity, and suggests changes in practice in the early years of the primary school which should prove to be highly relevant to the final educational outcome. If these changes were to lead to more success in developing the intellect, this would not imply less success in—or less concern for—the other aims of education, such as the development of aesthetic and moral values or practical skills. One might reasonably hope that the opposite would be true.

There is widespread pessimism at present—avowed and unavowed—about what is educationally possible, and the pessimism amounts to a self-fulfilling prophecy. There is, however, real reason for optimism if a sufficiently large number of people (parents, teachers—and, indeed, children) can be helped to believe that things might change.

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THE GIFTED CHILD SYNDROME

The main concern of this paper is to describe the findings of a research project into the relationships between children who are designated 'gifted' (by their parents) and their total environments. Matters arising from these relationships which have been investigated are described, in particular the overt behaviour of the children, and the attitudes of both parents and children to the educational environment.

Three groups of 70 children aged 5-13 years were compared. The first (T) was a sample taken from 4,500 children whose parents had joined the (British) National Association for Gifted Chidren (N.A.G.C.). The two control groups were found by screening all members of the target child's class. One set (C_1) were matched for age, sex, and ability. The other set (C_2) were matched for age and sex—ability was random. None of the parents in control groups belonged to N.A.G.C. The project involved 61 schools spread over the north-west of England. All homes and schools were visited.

The children had been initially screened and matched using the Raven's Matrices, but re-testing the children with the Terman-Merrill showed a statistically significant difference between the two matched ability groups (T and C_1). Comparison between the target and control groups showed considerable differences in children's behaviour and parents' attitudes.

All the children were re-allocated to two new groups—High IQ ($>$141) and Moderate IQ ($<$140) and these two groups were compared. Those features which had characterised the designated 'gifted' children (T) were not found to characterise the High IQ group, either in children's behaviour or parental attitudes. Further investigation showed that the children who had shown signs of unhappiness were more likely to come from 'unusual' home backgrounds. High intelligence of itself did not seem to bring about problems, but it was likely to accentuate the problems that some children already faced.

Unrecognised children of extremely high ability within the English school system, from stable families, do not show problem behaviours. It was concluded that those problem behaviours which are commonly attributed to gifted children are in fact representative of children of a range of abilities who are under some stress.

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A COMPARATIVE STUDY OF COGNITIVE STYLES OF THREE ETHNIC GROUPS

Witkin's theory of field-dependence/independence provides a useful conceptual framework within which relationship between socialisation practices and cognitive styles can be explored. There is a large body of empirical research (Witkin and Berry, 1975) which supports the view that emphasis on obedience and social conformity within the family leads to the development of the field-dependent cognitive style.

The present investigation was designed to explore the relationship between child-rearing practices and cognitive styles of three ethnic groups. Fifty English, 50 West Indian and 24 Asian subjects from a comprehensive school, studying in third forms (age 12-10 to 13-10), were tested on The Group Embedded Figures Test (Witkin *et al.*, 1971), spatial test (NFER, Spatial Test EG) and mathematical attainment test (NFER, Math EF). The subjects for the study belonged to IV, V, and VI occupational categories of the Registrar General's classification. Following previous researches in this field it was hypothesised that:

1. The Asian and the West Indian groups would be significantly lower in their scores on the GEFT test than the English group.
2. The Asians and the English would perform significantly better than the West Indians on the test of mathematics achievement.

No significant differences were found between the three groups on the GEFT and the spatial tests. However, on the mathematics attainment test the West Indians scored significantly lower than the other two groups: Means 85·5 (W.I.), 94·6 (A), 91·8 (E); Mean of the test = 100. No sex differences were found on any of the tests. Correlations between the various tests were moderate—which is in line with the Witkin's school of research (GEFT/Spatial = 0·61; GEFT/Maths = 0·50; Maths/Spatial = 0·57). These results are described in greater detail and related to previous findings in this area (Ghuman, 1977).

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CULTURE FAIRNESS VIA TESTS OF LEARNING ABILITY

Assessment and related provision raise in a very specific way the problems associated with fair educational treatment of minority groups. There have been many examples of the invalid use of tests, particularly with ethnic minorities, leading to questionable educational placements. Rogers (1973) documents a situation in this country where West Indians were over-represented in ESN schools, relative to the general population, by a factor of four.

In recent years a number of studies have been carried out that seek to apply learning ability notions to this problem, since intelligence-based measures have not resolved the difficulties. Among them is a study commissioned by the DES and recently completed at NFER. The materials used are based on the Haynes (1971) study of a sample of Sikh children in West London. The emphasis is on the child's capacity to learn rather than what he knows or has learned already; by involving the child in mini-learning situations it is endeavoured to measure his response to structured teaching. Since adequate grasp of English cannot be assumed the instructions are conveyed by demonstration and practice examples. A shorter group form is available for teacher use.

A predictive study was carried out using subsequent school achievement as criterion. A short form of the WISC was administered at the same time. The respective canonical correlations for the Learning Ability Test battery and the WISC battery with the criterion battery were 0·76 and 0·64. The same differential in favour of the Learning Ability Tests was found in the regression analyses, both in terms of the amount of variance explained and the order in which variables were chosen in the stepwise analysis. Further details are available in Hegarty (1978) and Hegarty and Lucas (1978).

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SCHOOL AND COMMUNITY IN GRAMPIAN REGION

"The community school . . . in Britain has not had much mention since its 1930 beginnings until the last few years. Why in the 1970s has it become fashionable? The answer may lie in the nature of society. . . . 'Community' has become an attractive concept signifying fellowship and participation" (Smith and Smith, 1974).

The Scottish Education Department awarded a research grant of £35,000 to Aberdeen University Education Department for a three-year project (1976-79) on school and community in the Grampian Region. A central part of the research has been the observation, analysis, and evaluation of school-community relationships in areas which have been recently provided with purpose-built community schools or community centres.

The first part of the project was given a 'school' emphasis, and the research was concerned with the way in which increased community awareness and involvement influence the school. The second half of the project was given a ' community ' emphasis—the questions of interest being how the school may be used for wider community purposes, as a focus for the community and as a community resource, and how other community activities flourish alongside school provision. Clearly in the day-to-day running of the project the division of emphasis was not so clear-cut as outlined above and both aspects were at times considered together.

A number of research approaches have been used—surveys, observation, interviewing, ' negotiated ' case studies—and these were discussed in relation to the possible development of various theoretical concepts and frameworks.

The OECD Report (1975) suggested that both *evolutionary* and *revolutionary* views of the community school can be distinguished. The evolutionary interpretation tends to result in marginal changes, such as dual use of facilities, or clear co-operation with parents, and curriculum developments which take pupils into the community. The revolutionary view demands *radical* changes, such as community involvement in the management of schools, or a reorientation of the curriculum to local needs, or developing ' social personalities with the attributes of constructive discontent' (Halsey, 1972). In Grampian region the pattern would appear to be basically evolutionary rather than revolutionary, though the array of social networks and their organisation in communities, the centralisation *vs.* decentralisation of facilities, how such aspects of community life are seen by participants, both public and professional, their expectations, values and attitudes, provide interesting possibilities for the research team in moving towards a framework of analysis in their final report.

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AFFECTIVE EDUCATION

It is difficult, but not impossible, to look at preventive mental health education outside the administrative framework of preventive mental health. In terms of organisation and social administration, the latter area seems to break down into primary prevention, that is the general rejigging of the social environment, the necessity for early screening—particularly the use of the school psychological and child guidance services for such screening and early therapy, plus the various forms of parental advice including health visiting and other services. Secondary prevention involves youth service counselling, adult education, local support groups, and the activities of national pressure groups, such as the National Association of Mental Health (MIND) and all general forms of social engineering which promote vocational guidance, recreation, and better living.

Looking at preventive mental health education overall, there are educative, i.e. training aspects, implicit in the professional and non-professional training of all those engaged in primary and secondary prevention, although much of the curricula of such diverse courses could not be regarded specifically as mental health education. However, there is also a direct educational approach to preventive mental health analogous in some respects with physical health education. It is this direct educational approach via school, college, and adult education, which forms the thrust of the present preventive mental health project and for which materials and strategies are being developed.

Four self-management programmes are in the process of development. These are: ' Lifting a Depression ', ' Easing Phobias, Fears and Tension States ', ' Controlling Habits and Impulses ', and ' Developing Social Skills '. Each is short, and intended for use by sufferers or would-be self-managers.

Unlike curative physical measures, some aspects of the curative process can also be used in a preventive sense, and so the instructors' manual incorporates the four programmes which become modules for a much longer and comprehensive offering. Participants are thus taught the four modules as contingent, curative measures.

Supplementary materials simplifying concepts in behavioural, developmental, clinical, and social pyschology are introduced as connective tissue to the modules, providing theoretical basis for identifying certain life-style determinants, and making it possible for participants to apply the methods of the self-management programmes intensively in their future lives.

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THE ROLE OF TRAINING IN THE ASSESSMENT OF LEARNING ABILITY IN MIGRANT CHILDREN: OVERCOMING LACK IN PERFORMANCE OR COMPETENCE?

The study is mainly a replication and extension of an earlier one (Kroeger, 1978). It had been found (a) that West Indian boys, average age 9 years, in Outer London, were doing as well as middle-class English and Indian boys on Inhelder/Piaget Multiple Matrices (MM) as a pre-test, and (b) that the two migrant groups profited more from a ten-minute training in post-test performance on the same test than did the British boys. There seemed to be transfer effects on Raven Coloured Progressive Matrices (CPM) in delayed post-tests.

There were not enough Indian subjects in the present study to allow statistical analysis. With regard to West Indian and British boys, the replication was successful inasmuch as (a) West Indians performed as well as British on the Inhelder/Piaget MM in the pre-test and (b) profited more from the training as demonstrated in the immediate post-test. On the Raven CPM, however, which for the first time was used as a pre-test as well, no difference between cultural groups was found. It is not clear whether this is due to the higher average age (10 years 4 months) or due to differences between the primary schools.

The question whether Raven CPM were really affected by a ten-minute procedure could be answered positively. Significant changes could be found in both cultural groups, especially with regard to those items in the Matrices which supposedly demand ' inductive reasoning '. The question whether the training overcame a lack in performance or competence would have to be answered with the latter, since the criterion is whether only one or both groups profit from the intervention. If only one group improves one would assume the ' actualization of existing competence ' (Dasan, 1975) rather than true cognitive development.

However, there is one indication of a differential effect of the intervention: for half of the sample (19 British, 35 West Indians) the (individual) training session was preceded by the administration of the Raven CPM. While for the British boys, some profit from simple retesting and others from the training, there are many in the West Indian group who profit from retesting as well as from training. It could be said then that these boys had more ' learning ability ' and thus more unused potential.

Just how much of unused potential there is, i.e. how much both groups can be pushed, and which part of the training (flexibility in identifying elements or insight that there is a rule to problems like the one presented) was responsible for the progress will be the subject of the next investigation.

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INITIAL READING MATERIALS EVALUATION THROUGH ELICITATION OF TEACHERS' PERSONAL CONSTRUCTS

Personal criteria of 125 teachers evaluating six prevalent initial reading programmes were elicited*, using repertory grid methods, and sub-samples were followed up over periods of up to 14 months. Principal component analysis of results, using Slater's Ingrid and Prefan computer programmes, demonstrates teacher preference patterns which are consistent over time and across educational settings.

Consideration of teachers' key constructs indicates their concern for fashionability, use of children's language forms, story content, variety of materials and degree of repetition rather than for information about teaching techniques of children's developmental characteristics, for built-in progress checks, for cost or durability.

Identification of teachers' evaluation criteria provides a basis for discussion of initial reading materials as facilitating diffusion of educational culture amongst teachers as well as from teachers to children, Also discussed are uses of the experimental techniques developed in enabling teachers to build their own cyclic evaluation models.

* Procedures adopted and results analyses undertaken are detailed in Chapter 7 of Labon, D., *Evaluating Initial Reading Materials*, Unpubl. Ph.D. Thesis, University of Sussex, 1977. British Library microfilm reference D 21345/77.

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THE LOTHIAN REGION EDUCATIONAL HOME VISITING SCHEME

In recent years studies of the growth and development of children have tended to suggest that educational disadvantage may occur as the result of one or more factors. Not least amongst these is the child-rearing patterns adopted by parents, and particularly by the mother, during the early years of the child's life. Other studies which may be referred to collectively as ' intervention programmes ' have indicated that it is possible to alter the conditions surrounding the early growth and development of the child.

More especially where the mother as the 'agent of intervention ' has been encouraged and provided with a clear programme of support the effects of the intervention appear to be long-lasting.

The Educational Home Visiting Project is an attempt to translate these findings into a scheme for initiating and sustaining intervention of such a nature in the Lothian Region. It is also an attempt to relate the programme of intervention to other well-established features of activity affecting the home, for example, nursery and primary school provision, social work support, health visitor teams, community groups.

The work of the educational home visitors raises a number of questions, some of which are currently being investigated by the Scottish Council for Research in Education. The effect of the visits on the future growth and development of the child, on the relationships of the mother with her child and with the community at large, on the expectations of the parents in relation to educational provision, on the capacity of the child to benefit from the educational facilities made available, indicate the range and variety of issues which are exposed by the scheme.

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AN ASSOCIATION BETWEEN HIGH INTELLECTUAL ABILITY AND AN IMAGINATIVE AND ANALYTIC APPROACH TO THE DISCUSSION OF OPEN QUESTIONS

The focus of the research presented here is the intellectual quality of pupils' spoken discourse. 105 16-year-olds read one of four passages on the theme ' Road Accidents ' and then discussed five questions related to the passage in small friendship groups. The discussions were recorded and comparisons were made between the contributions of pupils of ' high ' and ' low ' ability, as assessed by the AH4 Test of General Intelligence.

A cognitive-based method of analysis for spoken discourse had previously been developed (Michell and Peel, 1977) which drew on Peel's notions of Describer and Explainer Thinking (Peel, 1971). This method was applied to the transcripts of the recorded discussions which were also subjected to linguistic analyses and to a qualitative examination.

Results from the cognitive analysis revealed that pupils of ' higher ' ability sustained discussion for longer, achieved a higher cognitive level in their discourse and asked a larger number of interpretative questions. At a linguistic level, these pupils used more expressions of tentativeness and included more general referents in their discussions. A qualitative analysis of the discussions revealed three central differences between the groups which ensured that pupils in the ' high ' groups were at a constant advantage:

1. They sustained discussion by offering extended responses and by introducing new, relevant information and knowledge;
2. They focused on key themes and included only relevant arguments; and
3. They synthesised individual contributions to the discussion into a coherent whole.

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IS EYE-MUSCLE IMBALANCE A SIGNIFICANT FACTOR IN THE CAUSATION OF READING AND SPELLING PROBLEMS?

The conflicting research evidence in this field is reviewed, including some recent British studies. A structured interview is described, and results from a follow-up study of 56 backward readers are presented. It is shown that subjectively-experienced visual symptoms *are* significantly related to reading and spelling difficulties, but not to any particular diagnostic pattern of perceptual problems.

In an attempt to measure eye-muscle imbalance at reading distance, Maddox Rod and convergence tests were given to severely retarded spellers screened out from 16 schools. Again, significant results were obtained, but only for a particular combination of the measures used (esophoria and over-convergence).

A further study has been undertaken in which an objective measure of fluctuations in muscle control in a dynamic reading situation is obtained. Preliminary findings are presented, relating to test retest reliability and prediction of reading and spelling difficulties.

The implications of these studies for screening, assessment, treatment, and remedial teaching are discussed, using case-studies as examples.

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TEACHING STYLES IN NURSERY EDUCATION: SOME PRELIMINARY FINDINGS

Preliminary findings on baseline variation in style among a group of 20 teachers, and the effect on style of an experimental teaching approach with half of them, are presented. Teaching style is defined in terms of a number of observed interactional categories, together with the teachers' concepts about the children in their groups, obtained through repertory grid interviews. Observations and interviews were carried out on three successive occasions over a one-and-a-half-year period. Observational data collected on child behaviour are also briefly considered.

The concept of ' teaching style ' and its baseline variation are explored in a more flexible manner than in those previous studies which have selected teachers according to preconceived categories such as ' authoritarian ' *vs.* ' democratic ', ' structured ' *vs.* ' unstructured '. In the present study, nursery schools were selected from the Outer London boroughs on the basis of two criteria: a wide range of social classes in intake and a ' mainstream ' approach to teaching. Teachers within these schools were relatively homogeneous in so far as they agreed to participate in the project, and in the head teachers' views tended to represent the schools' ' best or usual practices '. Variation amongst these representatives of mainstream nursery teaching is the first focus of the study.

The introduction of an experimental approach was carried out by teachers and researchers developing flexibility from an initially offered set of principles. This development and practice of one-to-one work with individual children in the open classroom situation took place over a period of one-and-a-half terms. Teacher and researcher worked weekly together in the teacher's own classroom setting.

Effects of the experimental approach are examined in terms of change in the ways teachers were observed to interact with and view their children. Immediate and longer-term post-tests were carried out (the latter after a summer holiday and in relation to a new intake of children).

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CHANGES IN CONSERVATISM OF PRISON OFFICERS, POLICE OFFICERS AND SOCIAL WORKERS DURING TRAINING

This paper reports three projects which originated separately but have similarities in design and results.

In each project the Wilson Patterson Conservatism Scale or Attitude Inventory was used: on these higher scores indicate more conservatism.

Most prison officer recruits are men in their late twenties and they are usually non-graduates. In one part of the project 269 were tested, both at the start and at the end of their eight-week training. Another similar group was tested only at the end of training.

Police officers receive training at various stages of their careers. The project involved testing at various stages, but only that of recruits is reported in this abstract. 35 of these were tested before and after their ten-week training. Most of these recruits were men, the majority in their early twenties, and all were non-graduates.

The initial training of social workers varies according to their educational background. This project involved students on a two-year sandwich-type course; the majority were non-graduates. They were of average age 30 and roughly equal numbers of each sex. 38 were assessed early in their course and approximately 52 weeks later.

RESULTS

	Initial testing	Testing after period of training
Prison Officers (First Group)	47·80	45·10
Prison Officers (Second Group)		44·90
Police Officers	47·86	43·63
Social Workers	27·00	22·00

The results are discussed both with regard to communication between these professions and between each of them and the general public, and also with regard to the changes in scores during training.

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THE MOST IMPORTANT DEVELOPMENT NEEDED IN EDUCATION IS TO COME TO TERMS WITH VALUES

Data are presented in summary form to show:

That the main goals of Education are generally agreed to involve fostering qualities which are centrally concerned with values. They either involve influencing pupils' values or helping them to develop the value-laden competencies required to reach these goals effectively;

That the opinions of the teachers, pupils, parents, ex-pupils, employers, and employees we have interviewed, are in fact correct. Their views are borne out by other studies of the qualities people require to lead their lives effectively and to fulfil their potential;

That the fact that current examinations testify *only* to the development of stores of academic knowledge distracts teachers from the goals which everyone connected with the educational system believes to be most important, and which are, *in fact, educationally* the most important;

That what that last statement is really saying is that the *social* functions performed by the educational system in fact drive out its educational functions;

The fact that social pressures force teachers to work, against their wills, toward goals which they themselves do not believe to be *educationally* very important leads them:

(a) to behave toward their pupils in an autocratic, pressurising manner which
(b) leads them to fail to get to know their pupils and their values and talents

and as a result they are *unable* to help their pupils to develop their talents;

That, *as a result*, the educational system achieves its *main educational* goals extremely badly;

That the current demand for educational places reflects a desire for certificates which buy entry to a decent way of life, not a desire for the content of the education which is provided;

That pupils and students derive little benefit (other than their certificates) from the time they spend in the educational system; the knowledge they acquire is of little value to them, and they derive little of value from the later curriculum, such as it is;

That the outcomes of the educational process in the general education area are nothing short of frightening;

That the general conclusion to all this work can be captured by saying that the attempt to render education non-controversial has rendered it sterile;

That, if progress is to be made, we need to be able to assess, and, in practice *to assess*, these value-laden qualities as:

1. A basis on which to build an internally diversified system of education in which we help individual pupils to develop their own talents and potential, and measure them against different criteria;
2. A basis for the development and utilisation of talent in society and
3. (Unless and until there are broader changes in society which make selection unnecessary) a basis for our occupational certification procedures so that we can foster important qualities in schools.

That, in other words, if anyone's education is at fault, it is not that of those who fail to ' respond ' to the educational system, but our own education as leaders and managers of our societies.

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THE EVALUATION OF THE LOTHIAN REGION EDUCATIONAL HOME VISITING SCHEME

An ' illuminative ' evaluation of the Lothian Educational Home Visiting Scheme has been undertaken by the Scottish Council for Research in Education under contract with the Scottish Education Department. There was no provision for the collection and analysis of extensive statistical data.

The purpose of the evaluation was to set the Lothian scheme in the context of other similar schemes in the United Kingdom and the United States, to describe the operation of the scheme, and, in the light of the available literature, and a small number of interviews, to assess the scheme's probable impact on the children, parents, educational home visitors, schools, communities, and administrators directly or indirectly affected by the project.

The activities undertaken by the Educational Home Visitors vary considerably from EHV to EHV, and from family to family. Nevertheless, all the EHVs help to alleviate the mothers' loneliness and isolation, and show them new ways in which to entertain their children, thereby improving their relationship with them. They will also undoubtedly have a significant impact on the children's subsequent adjustment to school. Some visitors have helped some of the mothers to become better able to cope with the social institutions of our society, and the school system in particular. In some cases the schools involved seem to have become more open to parental involvement. Further results of this sort will be included in the final paper.

The project has led to a considerable advance in understanding of the issues and variables involved in schemes of this sort, and this spin-off from the project is felt by some to be, on its own, more than sufficient to justify the entire investment in the project.

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EFFECTIVE AFFECTIVE EDUCATION

Affective education or education dealing with emotional behaviour is recognised as important but problematic. Do teachers receive satisfactory guidance from psychological theory in this respect? (One notes objections that (i) affective development depends on teacher's personality; (ii) affect, cognition, perception are inextricably interwined; and James-Lange approach!) Reports on education—Newsom, Plowden, Bullock—give confusing impressions of emotional development in children and adolescents, e.g., ' exercising ' emotions, parallel between cognitive and emotional development, vague references to empathy. Consideration of psychological theories most often referred to in an admittedly biased, ' opportunity sample ' of student-teacher and in-service teacher essays and exam answers shows problems. Presentations of Bloom's taxonomy of objectives in the affective domain, Erikson's ' 8 ages of man ', Maslow's ' pyramid ' of needs indicate lack of clarity as to progression or continuation of affective responses; and strong admixture of philosophical and cognitive elements, especially in ' advanced ' stages.

Other popular themes—remedial counselling, personality theories—also may indicate vague underlying philosophy, or be descriptive only; again, cognitive elements are clearly present. Bruner's *Man: a Course of Study* does indicate evoking affect but does not show exactly what is to be done with affect aroused. (Possibly we should reconsider Herbart's theory!) The conclusions are that since cognitive elements keep coming into considerations of affective behaviour, we should accept them; there seems no indication that affective responses themselves develop to different levels; emotions are ineducable; what is educated or developed is cognitive awareness, cognitive analysis. We need more research to indicate the interaction of cognitive and affective responses. This does not mean purely cognitive education—affect is equally necessary and may have to be stimulated so that integration is possible.

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PERSPECTIVES ON LANGUAGE ACQUISITION: STUDENT TEACHERS AND SOCIAL SCIENTISTS

Teachers and certain practitioners in the applied social sciences may be thought to have implicit or explicit theories of language as a learned, an inherited, or an interactive phenomenon, and it seems possible that these conceptualisations have important implications for professional practice. Presumably, the views of social scientists are informed by their academic disciplines. College syllabuses would suggest that the opinions of student teachers are influenced, to some degree, by perspectives from the social sciences and from philosophy.

Final-year B.Ed. students ($N = 220$) and final-year social science students ($N = 46$) were asked to indicate, on a seven-point scale, the extent of their agreement or disagreement with each of 116 statements chosen to reflect, in approximately equal numbers, theories of language as classified by Houston (1971): behaviourist, cultural relativist-determinist, interactionist, preformationist-predeterminist.

Following exploratory analyses, responses to 29 statements were factor analysed: the principal axes method with varimax rotation was applied to the responses of the groups separately and together.

In the case of the student teachers, there were five significant and explicable factors accounting for 78·4 per cent of the total variance. The emergent factor structure would suggest that these students are somewhat more attuned to the rationalist than to the empiricist tradition. For the social scientists, the pattern was less clearly defined: six factors accounted for 79·4 per cent of the total variance and there seemed to be little support for the more extreme environmentalist views of language.

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STRATHCLYDE EXPERIMENT IN EDUCATION: A PROGRESS REPORT

There is extensive and impressive evidence to show that the current educational system is not effective for a large proportion of children. Many of the children who ' fail ' are to be found in ' areas of need ' where difficult social conditions are associated with a way of life divorced from the world of school. The potential and opportunity of young people brought up in ' areas of need ' are limited by low expectations, lack of understanding and negative reinforcements which are characteristics not only of home but of the school and of the community.

The 1971 Census Report and the work of the National Children's Bureau have brought to light the extent and complexity of urban deprivation in Strathclyde. In response, the Regional Council has declared its intention to tackle this serious social problem as a matter of urgency.

The Strathclyde Experiment in Education is an attempt to find a new approach to the education of children living in a small community in Govan. Situated in Moorpark Estate, a small enclosure of 500 houses, the experiment is focused on the socialisation system used by adults in shaping children's lives. Adults in each component of this intricate network—the family, community, and school—are often ignorant of the extent of their influence in the development of intellect and social awareness. By working with parents, community leaders, teachers, and other professionals, we are attempting to bring about a deeper understanding partnership in education.

The experiment is now in its third and penultimate year. Following a brief description of the fieldwork, preliminary results will be presented for a range of criteria including:

1. The response and attitude of parents and community leaders to the activities centred both on the Project House and on individual homes;
2. The reaction of parents and teachers to various strategies for improving home/school links;
3. The relationship between parent's response to the project activities and children's intellectual performance in school.

Finally some tentative conclusions will be attempted concerning the effectiveness of a community based educational enterprise in counteracting the symptoms of deprivation.

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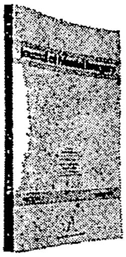

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